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Introduction to the USAF Total Force Cost Model

H. G. Massey

A Project AIR FORCE report
prepared for the
United States Air Force

Rand
SANTA MONICA, CA. 90406

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Design to produce time-phased total manpower and dollar requirements estimates for 15-year projections of alternative future USAF forces and support structures, the USAF Total Force Cost Model--sometimes referred to as the FORCE model--is currently operating on computers in the Air Staff Cost and Economic Analysis Division, Directorate of Management Analysis, Comptroller of the Air Force. This report presents an overview of the model, including its basic purposes and its relationship to the planning and programming process. Some examples and suggested applications are presented. Only the general features of the model and the methodology it employs are discussed. The FORCE model has potential for application in analysis of future forces for research and development planning; studies of alternative weapon systems for mission-oriented subsets of the force; and analysis of alternative future basing plans, training structure, or other support issues. (BG)

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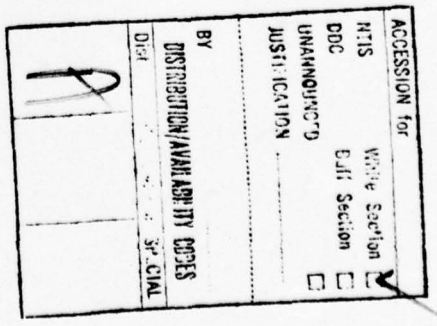
PREFACE

The USAF Total Force Cost Model was developed at Rand as part of the "Analytical Methodology Research" project under Project AIR FORCE (formerly Project RAND). The model is designed to produce time-phased total manpower and dollar requirements estimates for 15-year projections of alternative future USAF forces and support structures. It is currently operating on computers at Rand and in the Air Staff within the Cost and Economic Analysis Division, Directorate of Management Analysis, Comptroller of the Air Force.

This work was undertaken to provide a more comprehensive cost estimating tool for planning and studying future Air Force weapon systems and force mixes and alternative support policies. The model should be of interest to a wide range of Air Force offices and agencies engaged in various aspects of the planning and programming process. While it deals with the total Air Force structure, it is easily applied as well to subsets of the total structure, and to analysis of the impact on that structure of general support policies in base operating support, central supply and maintenance, formal training, and other personnel support functions.

This report presents an overview of the USAF Total Force Cost Model--sometimes referred to as the "FORCE" model. The basic purposes of the model and its relationship to the planning and programming process are discussed, and some examples and suggested applications are presented. Only the general features of the model and the methodology it employs are presented here. Detailed descriptions of the model and its input structure, as well as full documentation of the computer programs, are available in the form of two annexes, or "tabs": *Tab A: User's Guide to the USAF Total Force Cost Model*, and *Tab B: Programmer's Guide to the USAF Total Force Cost Model*. These tabs should be requested directly from The Rand Corporation.



SUMMARY

Through the annual planning, programming, and budgeting cycle the Air Force establishes its force structure within the constraints of the annual budget. To provide for the early funding requirements of future weapon systems and to keep the evolving force structure within anticipated future resource constraints, a multi-year programming approach is used. Planning for forces beyond the five-year *USAF Force and Financial Program* period is generally conducted outside the context of the total force, and as a consequence the merging of future plans with near-term programs frequently presents difficulties.

The USAF Total Force Cost Model is designed to provide a comprehensive and consistant means of projecting plans for the five-year program and for the years that follow. A computerized model that produces time-phased estimates of total manpower and dollar requirements for 15-year projections of USAF force and support structures, it can include all activities in the Air Force that generate resource requirements. Continuing activities that are outside the framework of customary weapon system cost models can thus be accounted for explicitly in estimating future total force costs. The subroutines for direct weapon system costs incorporated in the model resemble the "typical squadron" cost models currently used in the programming process, but they also provide additional capabilities. The model permits automated handling of certain routine cost and manpower calculations and automated calculation and time-phasing of development and procurement costs for major weapon system acquisition programs. Because of these and other features of the input structure, inputs can be prepared for a few systems or for many systems with a minimum of time-consuming hand calculations. Thus the model may be used to evaluate a variety of alternatives, in the full context of the total force structure, within a fairly brief period of time.

One principal feature of the USAF Total Force Cost Model that distinguishes it from other force cost models is its facility for dealing with support policy and support structure issues. Various categories

of support such as training, depot maintenance, and base operating support are treated in the model as joint functions of overall demand for support services and of separate, independent, support policy variables, which serve as proxies for the central policies governing each support category. Thus, future changes in training, base operations, or central supply and maintenance policy can be evaluated in the context of evolving future force structures, and tradeoffs between support structure and force modernization or force operations can be examined. The model's support algorithms provide the basic framework for these tradeoff studies, but currently available data and estimating relationships support only rudimentary analyses of this type. Further research into support policies and support resource requirements is needed to improve this situation.

The model also features a versatile report generator, which provides for a high degree of flexibility in structuring output results. The standard output resembles the *USAF Force and Financial Program* (F&FP) and aggregates results by appropriation, manpower category, and Major Force Program. The report generator allows the user to define alternative aggregations such as Defense Planning and Programming categories or Mission Area groupings of program elements. Cost elements can be aggregated into redefined appropriation categories as well, and a variety of subtotals can be generated. This permits users whose areas of interest cross traditional programmatic or appropriation lines to examine in detail those force elements or resource categories of particular interest to them.

To make full use of the model's capabilities, a base case must be prepared for the model on a periodic basis--probably once a year. The base case consists of a full 15-year set of inputs representing the current total Air Force program, for the period covered by the *USAF Force and Financial Program*, and a logical extension of that program for future years. The base case provides the means to calibrate model inputs to current Air Force policies and resource levels. The task of preparing it requires a fair concentration of effort, although many of the necessary force structure, activity rate, and cost and manpower inputs can be derived from the information currently generated by the Air

Staff in preparing major program updates such as the USAF Program Objective Memorandum (POM).

The Air Staff has used the USAF Total Force Cost Model in preparing the Air Force Extended Planning Annex--a 10-year extension of the 5-year program presented in the POM. The model also has potential for application in a variety of Air Force planning, analysis, and programming problems including: analysis of future forces for research and development planning; studies of alternative weapon systems for mission-oriented subsets of the force; analysis of alternative future basing plans, training structure, or other support issues; and evaluation of new weapon system or support manpower and cost estimating techniques for consistency and coverage in the context of total Air Force resource requirements.

ACKNOWLEDGMENTS

The author gratefully acknowledges the efforts of several Rand colleagues who have contributed to this project. David Cates was responsible for the principal computer programs. He, together with Harold E. Boren, Jr., and James A. Dryden, worked extensively on testing and operating the FORCE model and assembling the material for the user's and programmer's guides. Brent D. Bradley and Allen Barbour were contributors from the inception of this effort and offered many useful inputs in the development of the model. Ronald Hess was a principal contributor to the design of the training and personnel support areas of the model. Finally, Giles K. Smith and William H. Albright reviewed drafts of this report and provided many helpful suggestions.

CONTENTS

GLOSSARY

AF/ACB	USAF Directorate of the Budget
ALC	Air Logistics Center
BOS	Base operating support
DMIF	Industrially funded depot maintenance costs
EPA	AF Extended Planning Annex
FORCE	USAF Total Force Cost Model
F&FP	USAF Force and Financial Program
FYDP	Five Year Defense Program
ID-CODE	Identification code
IF	Industrial fund
LCC	Life cycle cost
MMH/FH	Maintenance manhours per flying hour
PACAF	Pacific Air Forces
PCS	Permanent change of station
POM	Program Objective Memorandum
TAC	Tactical Air Command
TOA	Total Obligational Authority
UE	Unit equipment
USAFE	U.S. Air Forces in Europe

I. INTRODUCTION

In preparing its annual budget request each year, the Air Force must choose from a number of weapon systems and operational and support policies those options that best meet its mission requirements within current budgeting, manpower, and other resource constraints. The process by which these choices are made is the annual planning, programming, and budgeting cycle, and the end-product of these choices is described in the Air Force's *Five Year Defense Program* (FYDP) and the more detailed *USAF Force and Financial Program* (F&FP). The FYDP and F&FP portray a five-year budget and force structure* projection, with the budget year being the first in the five-year period. This multi-year programming approach is needed because weapon systems and programs for future years may have funding implications in the current budget year. It is also needed because the continuing, future budgetary obligations implied by current programs must be considered in order to keep programs in balance with expected future available funds.

The problem of future resource constraints does not end at five years, however, and the Air Force often finds that it must make unforeseen compromises at the point in the programming cycle when last year's "sixth year" of the planning horizon becomes the fifth year in the updated five-year budget projection. The fact that there has been no easy way to generate total force cost estimates for future years and then compare them with projected total budgetary and other resource constraints has contributed to this problem. Cost estimates for proposed future weapon systems usually exclude cost elements and activities that are assumed to be insensitive to the alternatives with which they are compared. Hence the sum of the costs of the systems composing the future force structure is less than the total budget that would be required to support that force structure. In effect, this discontinuity in cost estimating makes it impossible to test the fiscal feasibility of future plans in a reasonable way.

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*The force structure projection actually covers a period of eight years--three years beyond the last year of the budget projection.

The work described in this report attempts to provide a single, internally consistent means of projecting across both the five-year program period and the years that follow. The cost model developed through this work is intended for analytical tasks ranging from future planning studies to the force sizing studies that precede final program formulation in the annual budget cycle.

The USAF Total Force Cost Model (FORCE) is a computerized model that produces time-phased estimates of the total dollar (Total Obligational Authority) and manpower requirements for 15-year projections of USAF force and support structures. Force structures are described in the model essentially as they are in the USAF F&FP, i.e., in terms of organizational units (wings, squadrons, etc.) and unit equipment (UE) aircraft and missiles of various types. Support structures are described in terms of numbers and types of bases, training units, and centralized maintenance (depot maintenance) facilities, and in terms of cost and manpower-estimating relationships that prescribe how support requirements vary with changes in force levels.

The model's output format resembles the F&FP, and its internal structure approximates the collective procedures and rules of thumb used by the Air Staff in estimating resource requirements for a multi-year force program. It is designed to include all Air Force activities represented in the F&FP and to provide a rational structure for projecting the future costs of continuing activities. For any proposed new system the user need only specify a phase-in schedule and a few inputs (procurement cost-quantity relationship, manning and operating cost factors, etc.) in order to obtain full, time-phased costs and manpower requirements. Support requirements--such as base operating support, training, and depot maintenance--are responsive both to force structure changes and to changes in support policy variables. The latter include inputs relating to support structure and other inputs measuring the impact on support of changes in force levels, flying hours, forcewide manpower totals, and other characteristics of the force structure.

The FORCE model is applicable to problems in the planning, and much of the programming, portions of the planning, programming, and budgeting cycle. In principle, the model can be used by an Air Force planning

or analysis office to examine a variety of future options, in the context of the total force, without having to expose all of the options to the entire Air Staff. Thus the model gives the individual functional office the capability to prepare inputs to the planning and program formulation process that are more likely to fit into the total program when they are combined with inputs from other parts of the Air Staff. When these inputs are combined, the FORCE model permits examination of total program options and trade-offs with much less effort than is required for a full Air Staff program exercise. This capability implies that a wider range of possibilities could be examined in the course of formulating the program before committing the larger resources of the Air Staff to a full and detailed examination of the preferred options.

In sum, the model provides a total force context for comparing and sifting future options down to the few that will require final assessment for program and budget decisions.

This report describes the FORCE model in general terms. It is addressed to personnel involved in the Air Force planning process and in the evaluation of future weapons systems and policies, as well as to cost analysts. We present here some illustrations of the model's output and a brief description of the structure of the submodels used to compute costs and manpower requirements. The cost analyst or reader who is concerned with the technical aspects of the FORCE model may obtain full details of the computations and procedures for using the model on request from The Rand Corporation. Documentation of the computer programs and copies of the programs may also be obtained on request.*

The analytical framework within which the FORCE model was designed is as essential to its use as are the computational routines. Based on the Program Element structure used in the FYDP and F&FP, the framework serves as a means of categorizing Air Force activities and accounting for all the requirements shown in the USAF budget. It also provides a frame of reference to relate future costs to current budgets and constraints. Much of the terminology used here is drawn from that used

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*Tab A: *User's Guide to the USAF Total Force Cost Model* and *Tab B: Programmer's Guide to the USAF Total Force Cost Model.*

in Air Force program and budget documents and in the planning, programming, and budgeting process.* Inputs to the model can be obtained from Air Force publications, such as the *USAF Cost and Planning Factors* (AFR 173-10), or can be derived from analysis of the F&FP, accounting data, or other Air Force program data sources.

Section II of this report presents the planning context within which the FORCE model was conceived and the specific objectives that guided the model's design. A general description of the model and its elements is presented in Sec. III. Section IV provides some illustrations of input data and output results produced by the FORCE model conceived and the specific objectives that guided the model's design. A general description of the model and its elements is presented in Sec. III. Sec. IV provides some illustrations of input data and output results produced by the FORCE model computer programs. Several applications and potential subjects for further research are discussed in Sec. V. The appendix presents a more detailed description of the elements and computational submodels used in the FORCE computer programs.

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*_The Air Force Budget_, a pamphlet published annually by the Comptroller of the Air Force, defines much of the terminology and contains a good brief description of the entire process (although it is primarily concerned with the budgeting phase).

II. EVALUATING RESOURCE REQUIREMENTS FOR FUTURE USAF PLANS

Cost is used as one of the criteria for evaluating weapon systems, subsystems, operating concepts, and support policies at many levels of management in the Air Force. In many instances the application of cost criteria is fairly obvious--two vendors offer similar services or similar items of equipment at different prices. Often, however, clear identification of the competing options and of the costs or resource requirements attached to those options is a much more complex problem. In the course of planning a total force structure, many such complex cost evaluations and choices must be made. Two basic approaches have been used by the Air Force to address these problems: the first, which prevails in the planning and analysis arena, is to formulate consistent procedures for comparing the costs of individual systems or subsets of the total force; the second, which prevails in the later stages of programming, is to use building-block cost estimates to evaluate marginal changes to a baseline force structure and budget.

APPROACHES TO EVALUATION

Comparative cost or resource requirements estimates can be used to evaluate alternatives because the systems or forces being compared are intended to perform the same mission (an equal-effectiveness comparison), and therefore the difference in cost among the alternatives is most telling. Using this type of analysis, one is less concerned with the absolute accuracy of the estimates as long as the alternatives are dealt with consistently. While this procedure provides valid and useful insights in general, problems arise when the results of the analysis must be merged with the results of comparative analysis of other parts of the force. Unless the cost estimates used are reasonable in an absolute sense, and unless the budgeted amounts used for the various segments of the force are consistent and non-overlapping, it is likely that the total cost of the force configured according to the individual analyses will conflict with expected or proposed future budget levels. It is probably impossible to avoid conflict altogether in this

situation, but it is important to avoid such gross imbalances that the products of the separate analyses cannot be used for total force planning.

Building-block cost estimates are used in later stages of programming in the Air Staff to try to resolve some of the force sizing conflicts that may have arisen in formulating the USAF Program Objective Memorandum (POM).* The final inputs to the POM, prepared through Air Staff exercises, generally entail detailed assessments of the entire force by the many specialized functional elements of the Air Staff. This process, which may involve several hundred people and require several days (or even weeks) to complete, is only used to sharpen the results of prior efforts. Thus, less time-consuming and more easily applied techniques are required prior to this stage of the process. Although the building-block approach serves this purpose, it suffers from an inability to address issues other than force structure (i.e., weapon system) issues, and it cannot be readily extended to the 10- to 15-year time horizon that is required to merge future planning objectives with current five-year plans.

In building-block force costing, one begins with a baseline total force cost, such as the current F&FP, and adds or subtracts weapon system building-block costs as force levels are varied from the baseline force structure. The "typical squadron costs" defined for this purpose represent the marginal costs of adding a squadron of a given type to the force structure (or the marginal savings from deleting an existing squadron).† They include direct operating costs and an allocated share of the cost of centrally provided support services, such as base operating support, training, and medical services. The thrust of this approach is directed toward marginal changes only, but there is an

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*The POM is the Air Force's proposal to the Secretary of Defense for the five-year force structure and budget estimates in support of the next year's budget submission. It is usually submitted in May each year. The Secretary's response to the proposal and the subsequent reworking of issues by the Air Force result in the budget proposal, which is usually completed in December of the same year.

†Development and procurement costs, in addition to operating costs, would be included for new weapon system programs.

implication that some portion of total force cost (i.e., that which is left over after the marginal costs of all weapon systems have been accounted for) is fixed or at least is insensitive to force level changes.

This approach can provide reasonable estimates of the change in total force cost resulting from a force structure alternative that is not too different from the baseline and where the time horizon does not extend beyond the last year of the F&FP. But when a wider range of alternatives, or a 10- or 15-year time horizon, is under consideration, two major problems arise. First, the implicit assumptions on which the marginal cost estimates are based may be violated. For example, the marginal training cost estimates are built on the assumption that existing training installations (with associated fixed costs) are suitable and have adequate capacity, but extensive force level changes might strain that assumption. Second, the baseline is lost when one looks beyond the five-year F&FP period. A simple straight-line projection of the fifth year's cost (with marginal, building-block changes) is inadequate because it implies costs are fixed over a long period when they probably are not. Many interesting weapon system and force structure changes involve lead times that require looking beyond the five-year horizon, so some better approaches to estimating the costs of future forces are needed.

A considerable portion of the USAF budget (approximately a third) is devoted to "general support" activities,* which are only partially affected by changes in force levels. Another fraction of the budget (one-fourth or more, depending on definitions) is devoted to functions that appear to be level-of-effort activities† almost completely

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*General Support is defined in the Defense Planning and Programming categories to include Base Operating Support, Medical Support, Other Individual Support, Training, Command, and Logistics. These categories are defined in general terms in *The Air Force Budget*, op. cit. Specific definitions, in terms of FYDP program elements, are revised annually in a Defense Department memorandum, which usually appears at the beginning of the calendar year.

†For example, some 150 active program elements appear in Major Force Program (MFP) 6 (Research and Development). While a few of these are development programs for specific new weapon systems, and others (Basic Research, Exploratory Development, Program-Wide Management and

unrelated to force levels. Neither of these sources of resource demand can be addressed in any adequate fashion within a building-block model. Support policy issues are occasionally addressed by special studies seeking near-term effects. But it seems likely that support policy changes having a major impact on resource requirements (e.g., changes in depot structure or base support structure) may require planning lead times of several years. Since support (and level-of-effort) activities and force structure draw from the same total pool of Air Force resources, it would be best to be able to address alternatives in both areas within the same general framework.

OBJECTIVES IN DESIGN OF FORCE MODEL

Consideration of the problems described above pointed out a number of objectives in our approach to designing a model to estimate resource requirements for USAF forces. These are outlined in Table 1.

The first objective is *comprehensiveness*. All elements of the force and support structure must be included specifically in the framework of the model, and they must be dealt with consistently. Of course, some activities and costs may be treated as levels of effort, while others are treated as functions of force structure-related variables. But consistency in the categories of cost and in total cost coverage must be maintained. Both dollar costs and manpower levels need to be included in the model. Manpower must be treated as a separate resource as well as a generator of direct dollar costs, because many support requirements are driven by manpower levels, and constraints are sometimes imposed on manpower levels independently of dollar constraints.

The second objective is to *improve the techniques for treating support* in the context of the total force. As a minimum, some disaggregation of support categories is needed. Training, for example, includes initial as well as continuing (e.g., skill progression) training,

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Support) are clearly set by Air Force policy at specific levels of effort, the majority of the advanced and engineering development programs appear to be funded at some aggregate level of effort. For total force cost projections beyond the five-year F&FP period, it is obvious that some resources would be required for such activities, although we cannot detail the specific programs to be pursued in the distant future.

Table 1

FORCE MODEL DESIGN OBJECTIVES

1. *Comprehensiveness*

   - o Explicitly represent all mission forces and support elements.
   - o Include both dollar costs and manpower.

2. *Improved treatment of support*

   - o Disaggregate large support categories.
   - o Explicitly represent interactions and interdependence of mission/support activities and support demands.
   - o Provide for separate manipulation of major support/infrastructure variables.

3. *Computational flexibility*

   - o Accept a variety of input modes.
   - o Internalize routine cost and manpower computations.
   - o Make cause-effect relationships explict.
   - o Provide multiple planning/output formats.

4. *Framework for resource analysis research*

and quite different training programs apply to pilots, other rated personnel, medical personnel, and other manpower categories. We have already noted that support costs are driven both by the needs of weapon systems and by separate and largely independent support policies. In recognition of this, the model must relate some portion of support costs to weapon system or force structure variables, and it must also relate a portion of support costs to variables that can be used to reflect support policies. Training loads, for example, are driven by turnover rates and changes in total force manpower levels--which are affected by force structure changes. Training policies, which are separate from training

loads, are reflected in variables such as staff/student ratios, average course lengths, and the level of fixed (insensitive to changes in student load) training facilities and manpower.

Computational flexibility is needed so that an analyst can quickly and easily determine the cost consequences of a variety of force structure and policy alternatives. The input structure should permit varying degrees of detail and a variety of cost and manpower relationships to be used for any element of the force. This allows the analyst to concentrate his efforts on those parts of the force that are most important to his study, and it also permits him to make use of new estimating relationships without major model revisions. Routine cost and manpower computations should be done within the model, where feasible, to minimize external data manipulation delays in structuring alternatives. Cause-effect relationships (i.e., which variables affect which resource categories) should be readily identifiable in the input structure. Flexibility in the volume and format of output and in the cost and force aggregations used to express results (i.e., aggregations other than Major Force Programs) is needed as a means to aid analysts whose areas of interest cut across traditional resource and programmatic lines.

Finally, it is important that the model serve as a *framework for resource analysis research*. This is particularly important in the case of indirect costs and support requirements, because existing techniques and cost factors in these areas have not been examined in a total force context. We must be able to account for the *total* resource requirements for Base Operating Support (BOS), for example, not just the portion attributed to, or allocated to, weapon systems. The model must provide the framework for developing and testing the necessary cost factors and relationships to deal with this problem. This objective requires that all factors that may have some impact on a given support or cost category be readily identifiable and easily addressable in the model's input structure.

III. DESCRIPTION OF USAF TOTAL FORCE COST MODEL

FRAMEWORK OF FORCE MODEL

The USAF Total Force Cost Model is a computerized set of computational routines combined with a basic analytical framework that is used to generate total resource requirement estimates for 15-year projections of USAF forces and support structures. We refer to it as the FORCE model--the name of the principal computer program.* The analytical framework is as essential a part of the FORCE model as are the computer programs, because it is the framework that provides the basis for deriving the necessary cost, manpower, and other estimating relationships, and other values that serve as inputs to the computer programs. The design of the model reflects the objectives outlined in the previous section, but the model is not a final and definitive answer to the problems we discussed. We first describe the FORCE model as it exists as of this writing, reserving for later discussion some aspects that appear to need further research.

The starting point for the analytical framework of the FORCE model is essentially the picture of the Air Force that is portrayed in the *USAF Force and Financial Program*. The F&FP is used here primarily as a means of establishing the total coverage of the model and of dividing the Air Force into a set of separate components that collectively account for the total USAF budget and manpower requirement. In the FORCE model we call these separate components planning elements. They are comparable, but not necessarily identical, to F&FP Program Elements. In the case of most weapon systems, a single Program Element might be divided into several FORCE model planning elements in order to account for cost and manning factor differences among differing aircraft series (e.g., F-4C, F-4D, F-4E), squadron sizes, or other characteristics. In other cases--particularly level-of-effort activities--it may be more convenient to aggregate several F&FP Program Elements in a single FORCE

*The computer program will be called the FORCE *program* to distinguish it from the more encompassing FORCE *model*.

model planning element. The total set of planning elements used in a series of FORCE model exercises must cover all of the activities and resources represented in the F&FP, but the level of detail or aggregation is up to the analyst and is a function of the availability of input factors and the character of the force and support structure alternatives to be examined.

In the FORCE model, the cost of the planning elements is divided into *appropriation categories*, as in the USAF F&FP. The sum of the appropriations is expressed as Total Obligational Authority (TOA), except for the Airlift Service Industrial Fund appropriation, which is excluded from TOA because funds for this purpose are reimbursed to the Air Force by users of airlift services, and are not included in the regular Air Force budget. Several cost categories are termed "non-add costs" in the FORCE model and are also excluded from TOA totals. For the most part these are used to identify to individual planning elements, certain support costs that are accounted for elsewhere in the F&FP structure. The most important of these categories are Depot Maintenance (Industrial Fund) and Permanent Change of Station (PCS) Travel. It is useful to see these costs in association with the weapon systems and other activities that generate requirements for them; but in order to track back to the F&FP structure it is necessary to account for them as above-the-line costs (included in TOA) in planning elements corresponding to the appropriate F&FP Program Elements. The appropriations and non-add cost categories are listed in Table 2.

All costs in the FORCE model are expressed in constant dollars, with the base year chosen as appropriate for the current planning, programming, and budgeting cycle. Although inputs can be provided in terms of escalated dollars within the existing structure, to do so would be extremely burdensome and could require some calculations to be done externally when they could easily be done internally in constant dollars. In Sec. V we suggest that provisions could be added to the REPORT WRITER program--which is used for reformatting and totaling FORCE program results--to calculate the impact of cost escalation under alternative sets of escalation rates.

Table 2

FORCE MODEL APPROPRIATIONS AND NON-ADD COST CATEGORIES

Appropriations Included in TOA	Appropriation Excluded from TOA
Aircraft Procurement	Airlift Service (IF)
Missile Procurement	
Other Procurement	Non-add Cost Categories
Military Construction	
Research and Development	Depot Maintenance
Operations and Maintenance (AF)	Medical Additive
Military Personnel	Miscellaneous Support (BOS)
AFR Personnel	PCS Travel
AFR Operations	
AFR Other	
ANG Personnel	
ANG Operations	
ANG Other	

The purpose of the main computational routines in the FORCE model is to generate time-phased forcewide manpower and TOA requirements from a set of inputs describing planning elements in terms of force structure (squadrons, UE, etc.), activity rates (flying hours, training loads, etc.), and various cost and manning factors. Although many planning elements may be treated as independent parts of the Air Force, proper treatment of certain support activities requires that interdependent aspects be treated as well. Figure 1 depicts the approach used in the FORCE model.

The total force consists of *mission planning elements*, shown at the top of the figure, and several types of *support planning elements*. The three mission and five support planning element types used in the model are listed in Table 3. Mission planning elements would include all of the major force structure elements (as described in the "Force and Equipage" section of the USAF F&FP) and others representing level-of-effort activities. Each is treated as an independent entity in the resource computations; i.e., requirements are computed from the inputs for that planning element alone. Resource requirements for support planning elements are functions of both forcewide "support demands" (e.g., total manpower in a given category, which affects training requirements)

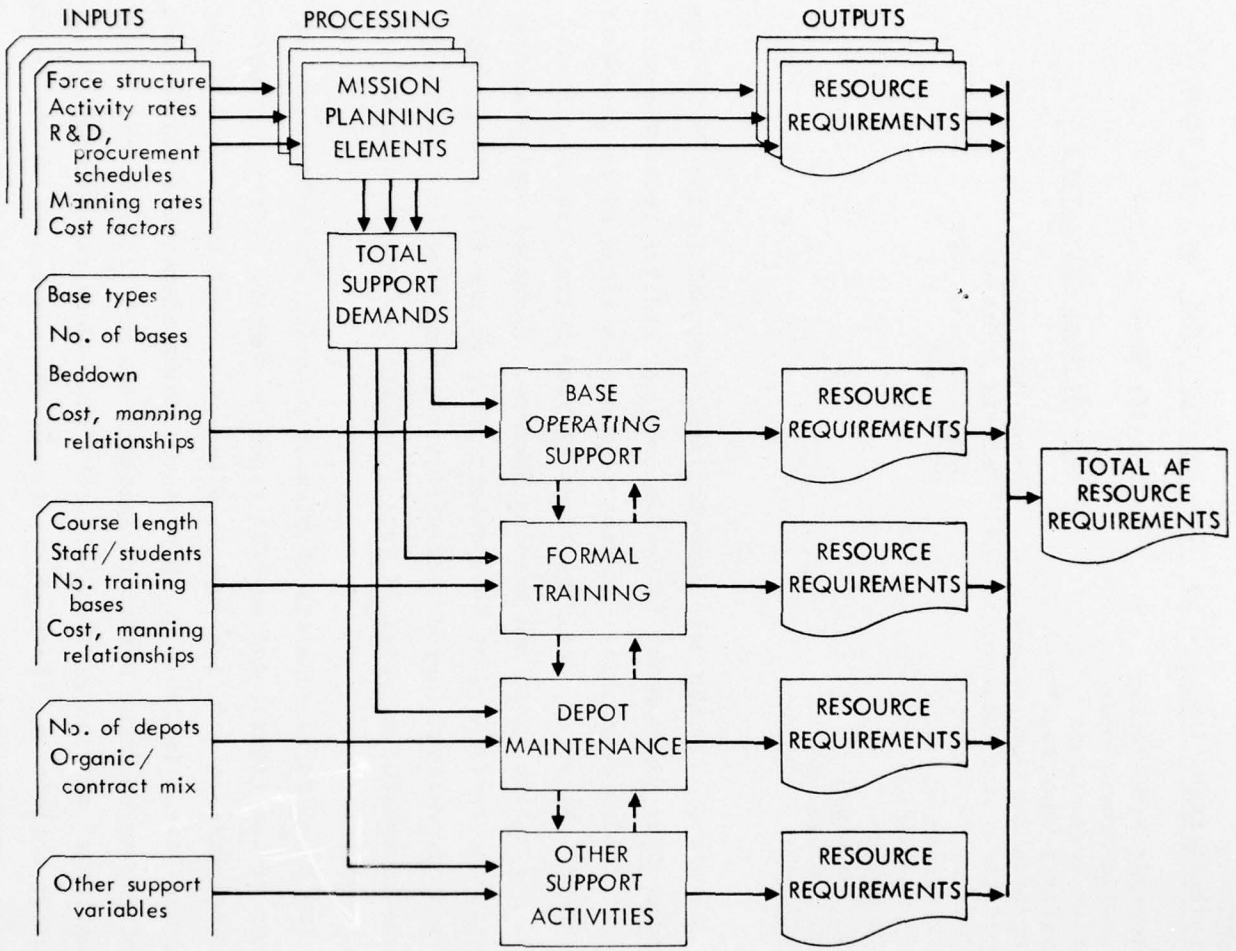

Fig. 1 — Structure of FORCE model computations

Table 3

FORCE MODEL PLANNING ELEMENT TYPES

Mission Planning Elements	Support Planning Elements
Aircraft Systems	Base Operating Support
Missile Systems	Training
Standard Systems[a]	Depot Maintenance
	PCS Travel
	Medical and Other Personnel Support

[a]This is a general category used to describe force elements (such as command, ground radars, or communications units) that do not operate major aircraft or missile weapon systems.

and independent "support policy variables" (e.g., turnover rates and fractions of new personnel receiving a given category of training). The major support-of-support interactions (e.g., BOS for training planning elements and training for other BOS planning elements) are represented by dashed lines between the support element boxes in Fig. 1. These interactions can be captured by appropriate ordering of the inputs to the model.

The explicit provisions within this framework for separate, independent support policy variables along with mission-generated support requirements are the principal features of the FORCE model that distinguish it from other force costing approaches. Because this capability has not existed in the past, there is no established set of factors and estimating relationships (such as those used for weapon system costing) to take immediate advantage of this capability. However, current data and factors can be adapted for use within this framework, and the model itself provides a useful tool for evaluating, in the total force context, new factors and support cost relationships that may be generated from future research.

EXERCISING THE FORCE MODEL

The computer programs used in exercising the FORCE model include:

1. A pair of programs, SORT and CREATE, which are used (a) to generate a FORCE input data set from punched cards and (b) after a basic data set has been prepared, to merge data cards representing changes to base case inputs for an alternative case.
2. The main computational routine, the FORCE program, which processes the input data and produces a standard set of output reports or prepares an output data set for further processing.
3. A versatile report generator, the REPORT WRITER program, which is capable of producing a variety of output reports from the data set generated by a FORCE program run.

All of these computer programs were written for the IBM 360 and 370 series computers. The computational routines for the various mission and support planning elements are briefly described in the appendix to this report.

A key to the use of the FORCE computer programs in costing alternative force plans is the concept of the base case. The base case consists of a full set of inputs for the 15-year* period describing the current Air Force program. Typically, this should be based on the F&FP coinciding with the President's Budget (January) or Program Objective Memorandum (May), as these are the major program updates in the planning cycle. The principal requirement is that the base case be comparable in the five-year program period to a current F&FP, because this is the means by which results are calibrated to current Air Force policies and resource levels. The preparation of the base case requires the greatest concentration of effort in using the FORCE model--exercising it in costing alternative programs merely requires specification of changes to the base. Most of the necessary force structure, activity rate, and cost

*Force structure inputs extend from one year prior to the first or "base" year through the seventeenth year.

and manning factor inputs are prepared currently as adjuncts to the preparation of the POM and President's Budget. With slight modification, these inputs can be used directly by the FORCE computer programs. Other inputs must be derived by analysis of the current program and budget as shown in the F&FP.

The base case should be constructed with some consideration of the types of force and policy changes that are to be addressed in forthcoming analyses. The analyst must divide the force into planning elements that are geared to this purpose. For example, if analyses might involve separate changes to TAC, PACAF, and USAFE F-4 squadrons, then separate planning elements should be defined for each type. The base case force structure for the various force elements should match that specified in the F&FP within the F&FP program period; and for the years beyond the F&FP time horizon, the force structure can simply reflect a leveling off of phase-ins and phase-outs begun in earlier years. (The purpose is simply to establish a baseline that represents the implications of current plans.) To provide for easy construction of inputs for alternative cases, it is best to generate the factors and other inputs for new systems (candidates for addition to the force in the later years) during the preparation of the base case.

Given this baseline, the only inputs that need be supplied to specify alternative cases are those that differ from the base case. Force levels are a key element in most alternatives, and the FORCE model is designed to relate most costs directly to force levels where this is desired. For example, changes in manpower requirements, in direct operating costs, in the time-phasing of development and procurement costs, and changes in forcewide support requirements, can all be generated from force level changes alone. Aircraft maintenance manpower requirements can be keyed to wartime or peacetime flying activity, and peacetime flying rates can be keyed to changes in aircrew ratios. The appendix explains in more detail the kind of relationships the model can represent.

Support structure changes can be examined simultaneously with, or separately from, force structure changes. Major support variables include the following:

- o Base Operating Support: number of bases, fixed manpower and costs per base (by major command and base type), variable manpower and costs (by major command and base type).
- o Training: turnover rates, average initial training course lengths, upgrade training rates (all by personnel type), number of training bases, fixed staff per base, variable staff-per-student requirements, and flying hour rates for instructors and students.

Other variables are available for other support categories.

Manpower and costs for the base case and alternatives are generated in terms that approximate the F&FP. The REPORT WRITER program can be used to generate displays of selected cost, manpower, force structure, and activity level data, and to compute summary totals for subsets of the Air Force other than, or in addition to, Major Force Programs (e.g., Defense Planning and Programming categories). The latter capability is particularly useful for analyses that focus on mission areas or other force and activity aggregations that depart from the usual programmatic definition. The REPORT WRITER can also be used to rearrange the categories of cost used in the model in order to track resources that are subsets of appropriations or that cut across appropriation lines (e.g., total pay and allowances cost for military, civilians, and reserves).

RELATIONSHIP TO CURRENT COST ESTIMATING PROCEDURES

In practice, most of the planning elements that compose the total force will be mission planning elements, and most of those will be the weapon systems that constitute the usual concept of the force structure. Since force structure and weapon system alternatives have been the primary concern of planning analyses, a good deal of weapon system cost modeling has been done in the past, and a substantial body of "accepted" cost factors for current weapon systems is available. The FORCE model is designed to make use of this data base to as great an extent as possible, and thus its routines for aircraft and missile operating costs closely resemble the corresponding models used currently within the Air Force.

The *USAF Cost and Planning Factors* (AFR 173-10) contains two aircraft system models (BACE and CACE) and a missile system model (MACE) used in developing "typical squadron costs" that represent "variable annual operating costs"* for various weapon systems. The BACE model is approximately the same as the model used for USAF Directorate of Budget (AF/ACB) "Squadron Typicals" in the Air Staff exercises for developing the USAF POM each year. The direct or "Primary Program Element" cost factors used in the BACE, CACE, or MACE models can be used more or less directly as inputs to the FORCE model. Some of the marginal support cost factors can also be used in the FORCE model, but some are not suitable. In any event, some other source of information is required to account for the portion of forcewide support cost not covered by marginal cost factors.

The F&FP is usually the source used to establish requirements not covered by typical squadron cost factors. Estimates can be evaluated for each planning element (and Program Element), and adjustments or throughputs† can be made for elements of cost that are either missing or poorly estimated with the generally available factor values. As an example, we have found that aircraft modification costs, other than Class IV (safety-of-flight) modifications, are not included in standard cost factors. By reference to the F&FP, the analyst can see that some of these are one-time investments (similar to new acquisition programs), which could be included as throughputs in the FORCE model inputs, while other modification cost requirements may be reasonably estimated by establishing somewhat higher recurring modification cost factors. The model's input structure accommodates quite generalized forms of cost factors and cost estimates in order to deal with this type of problem.‡

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*These are understood to represent the marginal operating and support costs associated with the addition to the force of a squadron of the indicated aircraft or missile system.

†"Throughputs" are inputs that are passed directly to the output and summary total routines without processing--other than being added to costs that may have been generated elsewhere in the same cost element.

‡Costs may be generated in any cost element as a function of force levels, flying hours, or manning levels, and factor values may be constant or may vary by year.

These generalized forms also permit changes in cost estimating methodology (e.g., aircraft replenishment spares cost, traditionally treated as a function of flying hours, could be estimated as a function of the number of squadrons, unit equipment, etc.) without necessitating any rewriting of the computer programs.

In the process of formulating the USAF Program Objective Memorandum, the Air Staff conducts a series of "program exercises" in which a proposed total force program is routed through various Air Staff functional offices so that each can assess the program's effect in its functional area. The support structure and acquisition costing routines in the FORCE model are designed to approximate this functional approach to force costing. Thus, to approximate the training requirements estimates, the FORCE model keeps account of total force manpower, by user-defined manpower categories, in each year. Using average turnover rates (annual replacements as a fraction of average manpower levels, by manpower category) and average initial training durations, it computes requirements for replacements and estimates the impacts on officers' training school, recruit training, and on initial technical, pilot, and other training requirements. These computations, performed at the forcewide level (rather than for each planning element), capture the impact of net changes in manpower levels as some force elements phase out while others phase into the force.

The procurement and development cost time-phasing routines built into the model are approximations of the detailed calculations that would be applied to weapon system acquisition programs in program exercises. These are designed to make use of a relatively small number of inputs for each system (cost-quantity curve, funding lead time, total development cost and development time-phasing pattern) and provide appropriately phased costs as the phase-in of each system is varied.

The need to deal with support requirements using a functional approach like that used in Air Staff exercises stems from the fact that this approach is much closer to the actual programming and budgeting process of the Air Force. Marginal support cost factors used in current models of typical squadron costs are useful for comparisons of weapon systems, but they are inadequate for the task of estimating total support

requirements several years into the future. The FORCE model is intended for use in evaluating a wide variety of future force options, and the functional approach provides a much better basis for making a logical extension of the implications of current support policies as well as for addressing possible changes to these policies. At its current stage of development, the model serves mainly as an outline for this kind of analysis rather than as a fully developed set of estimating techniques. The subroutines for formal training, base operating support, depot maintenance, and other personnel support used in the FORCE program at this time are first steps in the development of separate models of support functions. Experience in applying the model to actual Air Force planning problems is needed to bring about further improvements in estimating support requirements for future force structures.

IV. EXAMPLES

FORCE MODEL PLANNING ELEMENTS

The typical FORCE model base case for a current Air Force program would probably include 300 to 500 individual planning elements, depending on the degree to which weapon system Program Elements (from the F&FP) are broken into separate planning elements to account for differences in aircraft series (e.g., F-4C, F-4D, F-4E), squadron size, theatre of operation, etc., and depending also on the degree to which other Program Elements (e.g., those in MFP 6) are aggregated. In general, the input structure of the model permits data to be sparsely coded--zero values or appropriate default values are assumed when data cards are omitted from some variables, and values are assumed to remain constant from year to year (in the model's time frame) unless new values are entered. This feature makes for a fairly compact input data set even when fairly large numbers of planning elements are used in the model. Some examples below illustrate the kind of results that can be generated using the FORCE model computer programs.

Example 1: Aircraft System Planning Element

REPORT WRITER displays of the cost summary and the force and manpower summary for a typical aircraft system planning element are shown in Figs. 2 and 3. The example portrays a hypothetical new aircraft system, phased into the force during the 15-year period displayed by the model, that generates development and procurement costs as well as operating costs. Figure 4 shows the INPUT DATA report for this planning element. Generated by the FORCE program, the report shows both input values and intermediate results. (The sections showing *computed personnel* and *procurement and development costs* are intermediate results.) The cost and maintenance-manhours-per-flying-hour factors marked "STD" in Fig. 4 were obtained in the model from a list of "standard aircraft systems" factors defined as part of the forcewide inputs to the model; this feature permits one-time specification of factors for systems that

P. E. CODE 21130 ATTACK AIRCRAFT SQUADRONS 21- TAC CONUS SYS=1 SUB=0 PLANNING ELEMENT ID CODE-211300

COST SUMMARY ($MILLIONS)

		1976	*1977*	*1978*	*1979*	*1980*	*1981*	*1982*	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*
AIRCRAFT PROCUREMENT	**	23.5	277.2	363.8	462.4	598.6	599.1	564.7	535.6	514.1	477.0	228.7	18.6	20.0	20.0	20.0	
AIR VEHICLE	*	23.5	242.0	317.4	403.4	519.2	517.9	486.0	458.5	437.6	400.4	182.4	.0	.0	.0	.0	
INITIAL SUPPORT	*	.0	35.2	46.4	58.6	77.8	78.2	73.3	69.1	65.9	63.3	30.4	.0	.0	.0	.0	
MODIFICATIONS	*	.0	.0	.0	.1	.3	.6	1.2	1.7	2.3	2.9	3.5	4.0	4.3	4.3	4.3	
COMMON AGE	*	.0	.0	.0	.1	.2	.3	.6	.9	1.2	1.4	1.7	2.0	2.2	2.2	2.2	
REPLEN SPARES	*	.0	.0	.0	.3	1.0	2.0	3.6	5.4	7.2	9.0	10.8	12.6	13.5	13.5	13.5	
OTHER PROCUREMENT	**	.0	.0	.0	.0	.1	.3	.5	.7	.9	1.2	1.4	1.6	1.8	1.8	1.8	
VEH+BASE EQUIP	*	.0	.0	.0	.0	.1	.3	.5	.7	.9	1.2	1.4	1.6	1.8	1.8	1.8	
MIL CONSTRUCTION	**	.0	.0	.0	25.0	30.0	10.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
R D T & E	**	170.0	200.0	250.0	150.0	50.0	30.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
OTHER RDT&E	*	170.0	200.0	250.0	150.0	50.0	30.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
OPERATIONS AND MTCE	**	.0	.0	.0	5.4	16.1	32.0	56.6	85.0	113.3	141.6	169.9	198.2	212.4	212.4	212.4	
MISC SUPPORT	*	.0	.0	.0	.0	.1	.1	.2	.4	.5	.6	.7	.8	.9	.9	.9	
POL	*	.0	.0	.0	1.0	3.1	6.1	10.8	16.2	21.6	27.0	32.4	37.8	40.5	40.5	40.5	
SYS&GEN SUPP MIL	*	.0	.0	.0	3.2	9.7	19.3	34.2	51.3	68.4	85.5	102.6	119.7	128.2	128.2	128.2	
OTHER O&M	*	.0	.0	.0	1.1	3.2	6.4	11.4	17.1	22.8	28.5	34.2	39.9	42.7	42.7	42.7	
MILITARY PERSONNEL	**	.0	.0	.0	2.2	6.5	12.8	22.7	34.0	45.3	56.6	68.0	79.3	84.9	84.9	84.9	
OFFICERS PAY	*	.0	.0	.0	.9	2.6	5.2	9.3	13.9	18.6	23.2	27.9	32.5	34.8	34.8	34.8	
AIRMEN PAY	*	.0	.0	.0	1.3	3.8	7.6	13.4	20.0	26.7	33.4	40.1	46.8	50.1	50.1	50.1	
TOTAL OBLIG. AUTH.	***	193.5	477.2	613.8	645.0	701.3	684.2	644.5	655.2	673.7	676.4	468.0	297.8	319.0	319.0	319.0	
NON-ADD COMPUTATIONS																	
DEPOT MAINT	*	.0	.0	.0	.9	2.8	5.4	9.6	14.4	19.2	24.0	28.8	33.6	36.0	36.0	36.0	
MEDICAL ADDITIVE	*	.0	.0	.0	.1	.2	.3	.5	.8	1.1	1.3	1.6	1.8	2.0	2.0	2.0	
MISC SUPP-BOS	*	.0	.0	.0	.1	.4	.8	1.3	2.0	2.7	3.4	4.0	4.7	5.0	5.0	5.0	
P C S TRAVEL	*	.0	.0	.0	.1	.2	.5	.9	1.3	1.7	2.2	2.6	3.1	3.3	3.3	3.3	
TOTAL PROGRAM	****	193.5	477.2	613.8	646.2	704.8	691.2	656.8	673.7	698.4	707.3	505.0	341.0	365.3	365.3	365.3	
INVESTMENT	***	23.5	277.2	363.8	487.5	628.7	609.4	565.2	536.3	515.1	478.2	230.1	20.3	21.7	21.7	21.7	
OPERATIONS	***	.0	.0	.0	7.5	22.6	44.8	79.3	118.9	158.6	198.2	237.9	277.5	297.3	297.3	297.3	
DEVELOPMENT	***	170.0	200.0	250.0	150.0	50.0	30.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	

FIGURE 2 -- EXAMPLE 1: AIRCRAFT SYSTEM P.E. COST REPORT

P. E. CODE 21130 ATTACK AIRCRAFT SQUADRONS 21- TAC CONUS SYS=1 SUB=0 PLANNING ELEMENT ID CODE-211300

FORCE AND MANPOWER SUMMARY

		1976	*1977*	*1978*	*1979*	*1980*	*1981*	*1982*	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*
ATTACK-1 SQDN		0	0	0	0	1	2	3	5	7	9	11	13	15	15	15	15
UE AIRCRAFT		0	0	0	0	18	36	72	120	168	216	264	312	360	360	360	360
FLYING HOURS			0	0	0	3487	10462	20475	36000	54000	72000	90000	108000	126000	135000	135000	135000
TOTAL MIL	**	0	0	0	0	395	790	1556	2593	3632	4669	5708	6744	7781	7781	7781	7781
TOTAL OFFICER	*	0	0	0	0	92	184	367	612	857	1102	1346	1591	1836	1836	1836	1836
TOTAL AIRMEN	*	0	0	0	0	303	606	1189	1981	2775	3567	4360	5153	5945	5945	5945	5945
PILOTS		0	0	0	0	54	108	216	360	504	648	792	936	1080	1080	1080	1080
OTHER OFF		0	0	0	0	38	76	151	252	353	454	554	655	756	756	756	756
ACF MTC AMN		0	0	0	0	244	488	956	1593	2231	2868	3506	4143	4780	4780	4780	4780
OTHER AMN		0	0	0	0	59	118	233	388	544	699	854	1010	1165	1165	1165	1165

FIGURE 3 -- EXAMPLE 1: AIRCRAFT SYSTEM P.E. FORCE AND MANPOWER REPORT

P. E. CODE 21130-0 ATTACK AIRCRAFT SQUADRONS CMD 21- TAC THEATER- CONUS SUBSYS-0 SYS TYPE-1 ID CODE-211300
STANDARD ACFT MMH/FH FACTOR AND COST FACTORS WILL BE USED FOR THIS PE'S EQUIPMENT TYPE

FORCE LEVELS (END YR)		**1976**	*1977/87	*1978/88	*1979/89	*1980/90	*1981/91	*1982/92	*1983/93	**1984**	**1985**	**1986**
ATTACK-1 SQDN	*	0.0	0.0	0.0	0.0	1.00	2.00	3.00	5.00	7.00	9.00	11.00
	/		13.00	15.00	15.00	15.00	15.00	15.00	15.00			
UE ACFT/SQDN	*	0.0	0.0	0.0	0.0	18.00	18.00	24.00	24.00	24.00	24.00	24.00
	/		24.00	24.00	24.00	24.00	24.00	24.00	24.00			
BEDDOWN												
11- SAC AFB SQDN	*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.00	2.00	2.00	2.00
	/		2.00	2.00	2.00	2.00	2.00	2.00	2.00			
22- PAF AFB SQDN	*	0.0	0.0	0.0	0.0	0.0	0.0	1.00	1.00	1.00	1.00	1.00
	/		1.00	1.00	1.00	1.00	1.00	1.00	1.00			
21- TAC AFB SQDN	*	0.0	0.0	0.0	0.0	1.00	2.00	2.00	3.00	4.00	6.00	8.00
	/		10.00	12.00	12.00	12.00	12.00	12.00	12.00			

PERSONNEL INPUTS (CODE)		CODE (0) END YEAR MEN/UE--CODE (1) END YEAR CREWS/UE--CODE (2) END YEAR MEN/SQDN (OVERHEAD RATED OFFICERS PER SQDN 0.0) **1976**	*1977/87	*1978/88	*1979/89	*1980/90	*1981/91	*1982/92	*1983/93	**1984**	**1985**	**1986**
PILOTS (1)	*	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
(2.0000 MEN/CREW)	/		1.50	1.50	1.50	1.50	1.50	1.50	1.50			
OTHER OFF (0)	*	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10
(0.0)	/		2.10	2.10	2.10	2.10	2.10	2.10	2.10			
ACF MTC AMN (2)	*	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
(0.8000 X CALC MTCE)	/		20.00	20.00	20.00	20.00	20.00	20.00	20.00			
OTHER AMN (2)	*	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
(0.2000 X CALC MTCE)	/		3.00	3.00	3.00	3.00	3.00	3.00	3.00			

COMPUTED PERSONNEL		(END YEAR) MEN/SQDN (MMH/FH FACTOR = 30.000 STD) **1976**	*1977/87	*1978/88	*1979/89	*1980/90	*1981/91	*1982/92	*1983/93	**1984**	**1985**	**1986**
PILOTS	*	0.	0.	0.	0.	54.	54.	72.	72.	72.	72.	72.
	/		72.	72.	72.	72.	72.	72.	72.			
OTHER OFF	*	0.	0.	0.	0.	38.	38.	50.	50.	50.	50.	50.
	/		50.	50.	50.	50.	50.	50.	50.			
ACF MTC AMN	*	0.	0.	0.	0.	244.	244.	319.	319.	319.	319.	319.
	/		319.	319.	319.	319.	319.	319.	319.			
OTHER AMN	*	0.	0.	0.	0.	59.	59.	78.	78.	78.	78.	78.
	/		78.	78.	78.	78.	78.	78.	78.			
TOTAL OFFICER	*	0.	0.	0.	0.	92.	92.	122.	122.	122.	122.	122.
	/		122.	122.	122.	122.	122.	122.	122.			
TOTAL AIRMAN	*	0.	0.	0.	0.	303.	303.	396.	396.	396.	396.	396.
	/		396.	396.	396.	396.	396.	396.	396.			
CREWS PER SQDN (END YR)	*	0.	0.	0.	0.	27.	27.	36.	36.	36.	36.	36.
	/		36.	36.	36.	36.	36.	36.	36.			

ACTIVITY RATES		(900. ANN FH PCP 5. C'HD CREWS) (WAR FH/ACFT 720.) *1977/87	*1978/88	*1979/89	*1980/90	*1981/91	**1982**	**1983**	**1984**	**1985**	**1986**
AVG ANN FLYING HOURS PER CREW	*	225.	225.	225.	225.	225.	225.	225.	225.	225.	225.
	/	225.	225.	225.	225.	225.					
AVG ANN FLYING HOURS PER SQDN	*	0.	0.	0.	6975.	6975.	8190.	9000.	9000.	9000.	9000.
	/	9000.	9000.	9000.	9000.	9000.					

FIGURE 4 -- EXAMPLE 1: AIRCRAFT SYSTEM INPUT REPORT
(CONTINUED ON NEXT PAGE)

COST FACTORS	$/UE ACFT	$/FLYING HOUR	$/CREW
ACFT - MODIFICATIONS	12000. STD	0.	
ACFT - COMMON AGE	6000. STD	0.	
ACFT - REPL SPARES	0. STD	100. STD	
O&M - POL	0.	300. STD	
O&M - SYS/GEN SUPP MATL	0.	150. STD	
DEPOT MTCE (IF)	25000. STD	200. STD	

EQUIPMENT DELIVERIES (RATIO OF EQUIPMENT UNITS DELIVERED TO UE = 1.350) (PRIOR PROCUREMENT = 0. UNITS)

		*1977**	1978/90	1979/91	1980/92	1981/93	1982/94	1983/95	1984/96	1985/97	1986/98	1987/99	1988/ 0	1989/ 0
INPUT DELIVERIES	*	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	/		0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTAL DELIVERIES	*	0.	0.	0.	24.	24.	49.	65.	65.	65.	65.	65.	65.	0.
	/		0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

COST QUANTITY CURVE BREAKDOWN WITH A BUY PROGRAM LEAD-TIME OF 18. MONTHS
(1ST UNIT COST $ MIL= 35.000; SLOPE #1=0.850; 1ST BREAK POINT=999998.; SLOPE #2=0.850; 2ND BREAK POINT=999999.; SLOPE #3=0.850)

PROCUREMENT (PROC), INITIAL SUPPORT, AND DEVELOPMENT COST FACTORS AND PERCENTAGES
(ADVANCE BUY=0.10% OF BUY; RDT&E TOTAL COST $ MIL= 1000.0; INITIAL SUP COST $ MIL/UNIT= 0.0 ; INITIAL SUP= 0.15 OF PROC COST)
(TOA PATTERN NUMBER = 5) (YEAR OF IOC = 4 BY DEFAULT)

		IOC-7	*IOC-6*	*IOC-5*	*IOC-4*	*IOC-3*	*IOC-2*	*IOC-1*	**IOC**	*IOC+1*	*IOC+2*
DEV TOA FRACTIONS	*	0.0	0.0	0.0	0.15	0.17	0.20	0.25	0.15	0.05	0.03

PRIMARY EQUIPMENT, INITIAL SUPPORT, AND DEVELOPMENT COSTS ($ MILLIONS) APPN CODE = 11

		*1977/87	*1978/88	*1979/89	*1980/90	*1981/91	**1982**	**1983**	**1984**	**1985**	**1986**
BUY PROGRAM (UNITS)	*	0.0	12.000	24.000	37.000	57.000	64.000	65.000	65.000	65.000	65.000
	/	32.000	0.0	0.0	0.0	0.0					
PROCUREMENT COST	*	0.0	234.541	309.300	390.502	518.989	521.180	488.875	460.613	439.290	422.326
	/	202.623	0.0	0.0	0.0	0.0					
ADVANCE BUY	*	23.454	30.930	39.050	51.899	52.118	48.887	46.061	43.929	42.233	20.262
	/	0.0	0.0	0.0	0.0	0.0					
PRIOR YEAR CREDIT	*	0.0	-23.454	-30.930	-39.050	-51.899	-52.118	-48.887	-46.061	-43.929	-42.233
	/	-20.262	0.0	0.0	0.0	0.0					
PRIMARY EQUIP. (NET)	*	23.454	242.017	317.420	403.351	519.209	517.949	486.049	458.480	437.593	400.356
	/	182.361	0.0	0.0	0.0	0.0					
INITIAL SUPPORT	*	0.0	35.181	46.395	58.575	77.848	78.177	73.331	69.092	65.893	63.349
	/	30.393	0.0	0.0	0.0	0.0					
R D T & E	*	170.000	200.000	250.000	150.000	50.000	30.000	0.0	0.0	0.0	0.0
	/	0.0	0.0	0.0	0.0	0.0					

THROUGHPUTS AND OTHER COST FACTORS

			*1977/87	*1978/88	*1979/89	*1980/90	*1981/91	**1982**	**1983**	**1984**	**1985**	**1986**
MILITARY CONSTRUCTION	($MILLION)	*	0.0	0.0	0.0	25.000	30.000	10.000	0.0	0.0	0.0	0.0
		/	0.0	0.0	0.0	0.0	0.0					
O&M - SYS/GEN SUPP MATL	($MIL/UE)	*	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300
		/	0.300	0.300	0.300	0.300	0.300					
O&M - OTHER O&M	($MIL/UE)	*	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100
		/	0.100	0.100	0.100	0.100	0.100					
O&M - OTHER O&M	($/FH)	*	50.	50.	50.	50.	50.	50.	50.	50.	50.	50.
		/	50.	50.	50.	50.	50.					

FIGURE 4 (CONTINUED)

may be used in more than one planning element. A list of hypothetical standard aircraft systems and factors is shown in Fig. 5.

Figure 6 shows the 120-column input records used to generate the planning element reports shown in Figs. 2-4. We do not go into the details of input format here, but the general purpose of each type of record shown in Fig. 6 is discussed below. The record type is designated by its leftmost 3 digits.

301 record:	Program element code, title, and basic identifiers for the planning element.
302 records:	The first is the force structure--squadrons and UE per squadron. The next two are the "bed-down"--number of squadrons tenanted on bases outside the major command specified for this planning element.
303 records:	Manning factors, crew ratios, etc.
304 record:	Flying hour rates.
307 record:	Procurement "deliveries" data--to permit computation of delivery schedule from phase-in profile.
308 record:	Procurement cost-quantity curve, development total cost, and time-phasing inputs.
309 records:	Throughput costs and additional cost factors.

Example 2: Standard System Planning Element

In Fig. 7 we show the cost, force, and manpower summaries for a FORCE model "standard system." The standard system planning element is a very general form used when neither the aircraft or missile system submodels nor the support system submodels are appropriate. In this example the planning element represents a level-of-effort activity. Note that for this planning element, costs that would normally fall into the Operations and Maintenance appropriation are shown in the below-the-line AIRLIFT (IF) appropriation. Figure 8 shows the input data report for this planning element.

Example 3: Base Operating Support Planning Element

Output reports and an input data report for a hypothetical FORCE

EQUIP NAME	MMH/FH	ACFT REPL SPARES	ACFT COMMON AGE	ACFT MODS	DEPO MAINT (IF)	OTH MUNITIONS $/CREW	ACFT REPL SPARES	O&M SYS/GEN SUPP MATL	O&M POL	DEPO MAINT (IF)	O&M OTHER CHARGES
		<------------------COST FACTORS/UE				------------------>	<------------------COST FACTORS/FH				------------------>
ATTACK-1	30.	0.	6000.	12000.	25000.	0.	100.	150.	300.	200.	0.
ATTACK-2	20.	0.	8000.	11000.	13000.	0.	150.	130.	220.	120.	0.
B-3A	0.	0.	25000.	40000.	30000.	0.	300.	250.	1500.	400.	0.
B-4	0.	0.	30000.	40000.	90000.	0.	700.	300.	600.	300.	0.
B-5X	0.	0.	180000.	170000.	190000.	0.	400.	600.	800.	1200.	0.
CARGO-A	0.	0.	70000.	150000.	600000.	0.	300.	250.	1700.	900.	0.
CARGO-B	20.	0.	20000.	30000.	150000.	0.	70.	120.	900.	90.	0.

FIGURE 5 -- EXAMPLE 1: FACTORS FOR STANDARD AIRCRAFT SYSTEMS

```
                                                                                                   1         1         1
col nbr  1         2         3         4         5         6         7         8         9         0         1         2
123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890

RCRDx<pec->p<eq-nam><planning element name--------------------><un>cmts (cm=cmd;t=thea;s=sys)               idcode nxt
 301  21130 ATTACK-1ATTACK AIRCRAFT SQUADRONS                  SQDN2111                                     211300 302
    cm or>oc<ofh>|yr0||yr1|| 2 || 3 || 4 || 5 || 6 || 7 || 8 || 9 || 10|| 11|| 12|| 13|| 14|| 15|| 16|| 17|
 302 0      5  180                     118  218  324  5     7     9    11    13    15                       211300 302
 30211                                                    1    2                                            211300 302
 30222                                               1                                                      211300 303
    mmc111aa<fac>|yr0||yr1|| 2 || 3 || 4 || 5 || 6 || 7 || 8 || 9 || 10|| 11|| 12|| 13|| 14|| 15|| 16|| 17|
 303 11           2  1.5                                                                                    211300 303
 303 30              2.1                                                                                    211300 303
 303 52          .8   20                                                                                    211300 303
 303 62          .2    3                                                                                    211300 304
       x    <  <mmh><war>|yr1|| 2 || 3 || 4 || 5 || 6 || 7 || 8 || 9 || 10|| 11|| 12|| 13|| 14|| 15|| 16|| 17|
 304  0            720  225                                                                                 211300 307
          n   <del>prior|yrn||n+1|| +2|| +3|| +4|| +5|| +6|| +7|| +8|| +9||+10||+11||+12||+13||+14||+15||+15|
 307           1.35                                                                                         211300 308
         ce   <fu$>  sl1<br1>  sl2<br2>  sl3    lt   a%  isfr<is$>            rdte$ II  #-7-6-5-4-3-2-1+0+1+2
 308     11    35.  850                        18   10  .15                   1000    5                     211300 309
     ceP      | yr1|| yr2|| yr3||  4 ||  5 ||  6 ||  7 ||  8 ||  9 || 10 || 11 || 12 || 13 || 14 || 15 |
 309310                         25.0  30.0  10.0      -1                                                    211300 309
 309451          0.3                                                                                        211300 309
 309461           .1                                                                                        211300 309
 309462           50                                                                                        211300   0
```

FIGURE 6 -- EXAMPLE 1: INPUT RECORDS FOR AIRCRAFT SYSTEM PE

P. E. CODE 41020 CARGO SUPPORT SERVICES (IF) 41- MAC CONUS SYS=0 SUB=1 PLANNING ELEMENT ID CODE-140030

COST SUMMARY ($MILLIONS)

		1976	*1977*	*1978*	*1979*	*1980*	*1981*	*1982*	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*
OTHER PROCUREMENT	**	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
VEH+BASE EQUIP	*	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
MILITARY PERSONNEL	**	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9
OFFICERS PAY	*	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
AIRMEN PAY	*	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6
TOTAL OBLIG. AUTH.	***	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3
AIRLIFT (IF)	**	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9
CIVILIANS	*	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
MISC SUPPORT	*	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
OTHER O&M	*	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
NON-ADD COMPUTATIONS																	
MEDICAL ADDITIVE	*	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
MISC SUPP-BOS	*	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
P C S TRAVEL	*	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7
TOTAL PROGRAM	****	45.6	45.6	45.6	45.6	45.6	45.6	45.6	45.6	45.6	45.6	45.6	45.6	45.6	45.6	45.6	45.6
INVESTMENT	***	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
OPERATIONS	***	42.8	42.8	42.8	42.8	42.8	42.8	42.8	42.8	42.8	42.8	42.8	42.8	42.8	42.8	42.8	42.8

FORCE AND MANPOWER SUMMARY

UNIT		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
TOTAL MIL	**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
TOTAL CIV&TECH	**	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
TOTAL OFFICER	*	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
TOTAL AIRMEN	*	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
TOTAL CIVILIAN	*	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
OTHER OFF		300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
OTHER ANN		1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
OTHER CIV		400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400

FIGURE 7 -- EXAMPLE 2: STANDARD SYSTEM P.E. COST, FORCE, AND MANPOWER REPORTS

P. E. CODE 41020-0 CARGO SUPPORT SERVICES (IF) CMD 41- MAC THEATER- CONUS SUBSYS-1 SYS TYPE-0 ID CODE-140030

FORCE LEVELS (END YR)		**1976**	*1977/87	*1978/88	*1979/89	*1980/90	*1981/91	*1982/92	*1983/93	**1984**	**1985**	**1986**
UNIT	*	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	/		1.00	1.00	1.00	1.00	1.00	1.00	1.00			
BEDDOWN												
41- MAC AFB UNIT	*	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	/		1.00	1.00	1.00	1.00	1.00	1.00	1.00			

PERSONNEL INPUTS (OVERHEAD RATED OFFICERS PER UNIT 0.0)

END YEAR MEN/UNIT		**1976**	*1977/87	*1978/88	*1979/89	*1980/90	*1981/91	*1982/92	*1983/93	**1984**	**1985**	**1986**
OTHER OFF (0)	*	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00
(0.0)	/		300.00	300.00	300.00	300.00	300.00	300.00	300.00			
OTHER AMN (0)	*	1500.00	1500.00	1500.00	1500.00	1500.00	1500.00	1500.00	1500.00	1500.00	1500.00	1500.00
(0.0)	/		1500.00	1500.00	1500.00	1500.00	1500.00	1500.00	1500.00			
OTHER CIV (0)	*	400.00	400.00	400.00	400.00	400.00	400.00	400.00	400.00	400.00	400.00	400.00
(0.0)	/		400.00	400.00	400.00	400.00	400.00	400.00	400.00			

COMPUTED PERSONNEL (END YEAR) MEN/UNIT		**1976**	*1977/87	*1978/88	*1979/89	*1980/90	*1981/91	*1982/92	*1983/93	**1984**	**1985**	**1986**
OTHER OFF	*	300.	300.	300.	300.	300.	300.	300.	300.	300.	300.	300.
	/		300.	300.	300.	300.	300.	300.	300.			
OTHER AMN	*	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.
	/		1500.	1500.	1500.	1500.	1500.	1500.	1500.			
OTHER CIV	*	400.	400.	400.	400.	400.	400.	400.	400.	400.	400.	400.
	/		400.	400.	400.	400.	400.	400.	400.			
TOTAL OFFICER	*	300.	300.	300.	300.	300.	300.	300.	300.	300.	300.	300.
	/		300.	300.	300.	300.	300.	300.	300.			
TOTAL AIRMAN	*	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.	1500.
	/		1500.	1500.	1500.	1500.	1500.	1500.	1500.			
TOTAL CIVILIAN	*	400.	400.	400.	400.	400.	400.	400.	400.	400.	400.	400.
	/		400.	400.	400.	400.	400.	400.	400.			

THROUGHPUTS AND OTHER COST FACTORS

			*1977/87	*1978/88	*1979/89	*1980/90	*1981/91	**1982**	**1983**	**1984**	**1985**	**1986**
O&M - OTHER O&M	($MILLION)	*	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000
		/	20.000	20.000	20.000	20.000	20.000					

FIGURE 8 -- EXAMPLE 2: STANDARD SYSTEM INPUT REPORT

model BOS planning element are shown in Figs. 9 and 10. BOS elements are used for each command/base type category in the FORCE model; in this example we show one for SAC bases. Although these bases could represent all Strategic Air Command bases or a subset of them (e.g., northern U.S. bases), in this case they are merely a nominal example. Since BOS cost and manpower requirements are partly driven by the total number of personnel supported, it is useful to the analyst to see what this total is. The input data report shows how many personnel were accumulated against the command/base category from previous planning elements. The factors used to generate variable BOS personnel and total weighted personnel supported* are included in the forcewide data input for the model.

The PERS SUPPTD values may be used as activity rates, in much the same manner as flying hours are used, to generate costs for the BOS planning element. A set of command and base-type parameters, including those for the SAC BOS planning element used in this example, is shown in Fig. 11. Note that in addition to BOS factors, civilian pay is defined by command/base category.

REPORT WRITER OUTPUT OPTIONS

The REPORT WRITER program is used to provide flexibility both in the kind of summary totals generated for a FORCE model run and in the information selected for display. The summary-total feature permits the analyst to group planning elements by command, by type of system (aircraft, missile, other), by theatre, and by several other planning element identifiers. A set of default conditions in the REPORT WRITER is used to define planning element groups (sums of planning elements) and accumulators (sums of groups) that are equivalent to the ten F&FP Major Force Programs. These conditions are shown in Table 4 in the format used by the REPORT WRITER. An alternative set of group and accumulator definitions is shown in Table 5. The analyst can define groups in a variety of ways, only a few of which are illustrated here.

---

*Officers, airmen, and civilians may be weighted differently, in terms of their effect on BOS costs, in establishing total "weighted personnel supported."

P. E. CODE 11896 BASE OPERATING SUPPORT (SAC) 11- SAC CONUS SYS=4 SUB=0 PLANNING ELEMENT ID CODE-511100

COST SUMMARY ($MILLIONS)

		1976	*1977*	*1978*	*1979*	*1980*	*1981*	*1982*	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*
OTHER PROCUREMENT	**	19.5	19.5	18.7	17.0	16.2	16.2	16.2	16.3	16.4	16.4	16.4	16.4	16.4	16.4	16.4	
ELEC&COMMUN EQPT	*	2.0	2.0	1.9	1.7	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	
VEH+BASE EQUIP	*	17.5	17.5	16.8	15.3	14.6	14.6	14.6	14.7	14.8	14.8	14.8	14.8	14.8	14.8	14.8	
MIL CONSTRUCTION	**	18.2	15.0	16.5	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	
OPERATIONS AND MTCE	**	234.6	235.3	231.7	224.1	220.8	221.3	222.7	225.9	229.2	231.1	231.4	231.3	231.3	231.3	231.3	
CIVILIANS	*	95.4	95.6	93.5	89.3	87.3	87.5	87.9	89.0	90.1	90.7	90.8	90.8	90.8	90.8	90.8	
MISC SUPPORT	*	52.8	52.9	51.2	47.9	46.3	46.4	46.6	47.0	47.4	47.6	47.7	47.7	47.7	47.7	47.7	
SYS&GEN SUPP MTL	*	37.8	38.0	38.0	38.0	38.1	38.3	38.6	39.3	40.1	40.6	40.7	40.6	40.6	40.6	40.6	
OTHER O&M	*	48.6	48.9	48.9	48.9	49.0	49.2	49.6	50.6	51.6	52.2	52.3	52.2	52.2	52.2	52.2	
MILITARY PERSONNEL	**	195.7	196.2	192.6	184.9	181.5	181.8	182.9	185.3	187.8	189.2	189.5	189.4	189.4	189.4	189.4	
OFFICERS PAY	*	19.0	19.0	18.4	17.2	16.5	16.6	16.6	16.8	16.9	17.0	17.0	17.0	17.0	17.0	17.0	
AIRMEN PAY	*	176.7	177.2	174.1	167.8	164.9	165.3	166.2	168.5	170.9	172.3	172.5	172.4	172.4	172.4	172.4	
TOTAL OBLIG. AUTH.	***	467.9	466.0	459.4	445.1	437.5	438.4	440.8	446.4	452.3	455.8	456.3	456.1	456.1	456.1	456.1	
NON-ADD COMPUTATIONS																	
MEDICAL ADDITIVE	*	5.3	5.3	5.3	5.0	5.0	5.0	5.0	5.1	5.1	5.2	5.2	5.2	5.2	5.2	5.2	
MISC SUPP-BOS	*	14.2	14.3	14.0	13.5	13.2	13.3	13.3	13.5	13.7	13.8	13.8	13.8	13.8	13.8	13.8	
P C S TRAVEL	*	8.3	8.3	8.2	7.9	7.7	7.7	7.8	7.9	8.0	8.1	8.1	8.1	8.1	8.1	8.1	
TOTAL PROGRAM	****	495.8	494.0	486.9	471.5	463.4	464.3	467.0	472.9	479.1	482.8	483.4	483.1	483.1	483.1	483.1	
INVESTMENT	***	37.7	34.5	35.2	36.0	35.2	35.2	35.2	35.3	35.4	35.4	35.4	35.4	35.4	35.4	35.4	
OPERATIONS	***	430.2	431.6	424.2	409.1	402.3	403.2	405.6	411.1	416.9	420.3	420.9	420.7	420.7	420.7	420.7	

FORCE AND MANPOWER SUMMARY

SAC BASE		10	10	10	9	8	8	8	8	8	8	8	8	8	8	8	
PERS SUPPTD			108029	108557	108653	108653	108959	109297	110237	112389	114649	115973	116186	116090	116090	116090	116090
TOTAL MIL	**	21979	22089	22113	21287	20461	20539	20548	20779	21096	21355	21434	21410	21410	21410	21410	
TOTAL CIV&TECH	**	8283	8320	8328	7957	7586	7612	7615	7692	7797	7884	7910	7902	7902	7902	7902	
TOTAL OFFICER	*	1076	1079	1079	1008	937	939	940	946	954	961	963	963	963	963	963	
TOTAL AIRMEN	*	20903	21010	21034	20279	19524	19600	19608	19833	20142	20394	20471	20447	20447	20447	20447	
TOTAL CIVILIAN	*	8283	8320	8328	7957	7586	7612	7615	7692	7797	7884	7910	7902	7902	7902	7902	
OTHER OFF		1076	1079	1079	1008	937	939	940	946	954	961	963	963	963	963	963	
OTHER AMN		20903	21010	21034	20279	19524	19600	19608	19833	20142	20394	20471	20447	20447	20447	20447	
OTHER CIV		8283	8320	8328	7957	7586	7612	7615	7692	7797	7884	7910	7902	7902	7902	7902	

FIGURE 9 -- EXAMPLE 3: BASE OPERATING SUPPORT P.E. COST, FORCE, AND MANPOWER REPORTS

P. E. CODE 11896-0 BASE OPERATING SUPPORT (SAC) CMD 11- SAC THEATER- CONUS SUBSYS-0 SYS TYPE-4 ID CODE-511100

NUMBER OF BASE (END YEAR)

		1976	*1977/87	*1978/88	*1979/89	*1980/90	*1981/91	*1982/92	*1983/93	**1984**	**1985**	**1986**
SAC BASE	*	10.00	10.00	10.00	9.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
	/		8.00	8.00	8.00	8.00	8.00	8.00	8.00			

PERSONNEL INPUTS (OVERHEAD RATED OFFICERS PER BASE 0.0)

END YEAR MEN/BASE

		1976	*1977/87	*1978/88	*1979/89	*1980/90	*1981/91	*1982/92	*1983/93	**1984**	**1985**	**1986**
OTHER OFF (0)	*	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00
(0.0200 X VAR BOS PERS)	/		71.00	71.00	71.00	71.00	71.00	71.00	71.00			
OTHER AMN (0)	*	755.00	755.00	755.00	755.00	755.00	755.00	755.00	755.00	755.00	755.00	755.00
(0.7300 X VAR BOS PERS)	/		755.00	755.00	755.00	755.00	755.00	755.00	755.00			
OTHER CIV (0)	*	371.00	371.00	371.00	371.00	371.00	371.00	371.00	371.00	371.00	371.00	371.00
(0.2500 X VAR BOS PERS)	/		371.00	371.00	371.00	371.00	371.00	371.00	371.00			

ACCUMULATED PERSONNEL TOTAL -- SAC AFB BASE

		1976	*1977/87	*1978/88	*1979/89	*1980/90	*1981/91	*1982/92	*1983/93	**1984**	**1985**	**1986**
TOTAL OFFICER	*	3316.	3449.	3489.	3489.	3489.	3555.	3583.	3890.	4291.	4573.	4664.
	/		4624.	4624.	4624.	4624.	4624.	4624.	4624.			
TOTAL AIRMAN	*	101583.	102294.	102434.	102434.	102434.	102970.	103007.	104493.	106553.	108272.	108789.
	/		108649.	108649.	108649.	108649.	108649.	108649.	108649.			
TOTAL CIVILIAN	*	2698.	2718.	2730.	2730.	2730.	2740.	2740.	2760.	2790.	2820.	2830.
	/		2818.	2818.	2818.	2818.	2818.	2818.	2818.			

COMPUTED PERSONNEL (END YEAR) FIXED + VARIABLE MEN PER BASE

		1976	*1977/87	*1978/88	*1979/89	*1980/90	*1981/91	*1982/92	*1983/93	**1984**	**1985**	**1986**
OTHER OFF	*	108.	108.	108.	112.	117.	117.	117.	118.	119.	120.	120.
	/		120.	120.	120.	120.	120.	120.	120.			
OTHER AMN	*	2090.	2101.	2103.	2253.	2440.	2450.	2451.	2479.	2518.	2549.	2559.
	/		2556.	2556.	2556.	2556.	2556.	2556.	2556.			
OTHER CIV	*	828.	832.	833.	884.	948.	951.	952.	961.	975.	985.	989.
	/		988.	988.	988.	988.	988.	988.	988.			
TOTAL OFFICER	*	108.	108.	108.	112.	117.	117.	117.	118.	119.	120.	120.
	/		120.	120.	120.	120.						
TOTAL AIRMAN	*	2090.	2101.	2103.	2253.	2440.	2450.	2451.	2479.	2518.	2549.	2559.
	/		2556.	2556.	2556.	2556.						
TOTAL CIVILIAN	*	828.	832.	833.	884.	948.	951.	952.	961.	975.	985.	989.
	/		988.	988.	988.	988.						

ACTIVITY RATES

		*1977/87	*1978/88	*1979/89	*1980/90	*1981/91	**1982**	**1983**	**1984**	**1985**	**1986**
PERS SUPPTD PER BASE	*	10803.	10856.	11437.	12783.	13620.	13662.	13780.	14049.	14331.	14497.
	/	14523.	14511.	14511.	14511.	14511.					

FIGURE 10 -- EXAMPLE 3: BASE OPERATING SUPPORT P.E. INPUT REPORT
(CONTINUED ON NEXT PAGE)

COST FACTORS	$/BASE	$/PERS SUPPTD
O&M - MISC SUPPORT	3060000.	150.
O&M - SYS/GEN SUPP MATL	0.	350.
O&M - OTHER O&M	0.	450.
OTH - ELECT & TELECOM	200000.	0.

THROUGHPUTS AND OTHER COST FACTORS

			*1977/87	*1978/88	*1979/89	*1980/90	*1981/91	**1982**	**1983**	**1984**	**1985**	**1986**
MILITARY CONSTRUCTION	($MILLION)	*	18.200	15.000	16.500	19.000	19.000	19.000	19.000	19.000	19.000	19.000
		/	19.000	19.000	19.000	19.000	19.000					
O&M - MISC SUPPORT	($/OFF)	*	200.	200.	200.	200.	200.	200.	200.	200.	200.	200.
		/	200.	200.	200.	200.	200.					
O&M - MISC SUPPORT	($/AMN)	*	95.	95.	95.	95.	95.	95.	95.	95.	95.	95.
		/	95.	95.	95.	95.	95.					
O&M - MISC SUPPORT	($/CIV)	*	150.	150.	150.	150.	150.	150.	150.	150.	150.	150.
		/	150.	150.	150.	150.	150.					
OTH - VEH&OTH BASE EQUP	($M/UNIT)	*	1.250	1.250	1.250	1.250	1.250	1.250	1.250	1.250	1.250	1.250
		/	1.250	1.250	1.250	1.250	1.250					

FIGURE 10 (CONTINUED)

BOS IDENTIFIERS			CIVILIAN	<---------BOS VARIABLE PERS. FACTORS--------->							<-----PERS. SUPPORTED WEIGHTING FACTORS------>						
				ACTIVE DUTY			AFR		ANG		ACTIVE DUTY			AFR		ANG	
CODE	COMMAND	BASE	PAY	OFF	AMN	CIV	MIL	TECH	MIL	TECH	OFF	AMN	CIV	MIL	TECH	MIL	TECH
11	SAC	AFB	11487.	0.17	0.17	0.17	0.0	0.0	0.0	0.0	1.00	1.00	1.00	0.0	0.0	0.0	0.0
12	ADC	AFB	11700.	0.17	0.17	0.17	0.0	0.0	0.0	0.0	1.00	1.00	1.00	0.0	0.0	0.0	0.0
21	TAC	AFB	11330.	0.17	0.17	0.17	0.0	0.0	0.0	0.0	1.00	1.00	1.00	0.0	0.0	0.0	0.0
22	PAF	AFB	7863.	0.17	0.17	0.17	0.0	0.0	0.0	0.0	1.00	1.00	1.00	0.0	0.0	0.0	0.0
24	AFE	AFB	10700.	0.10	0.10	0.10	0.0	0.0	0.0	0.0	1.00	1.00	1.00	0.0	0.0	0.0	0.0
41	MAC	AFB	11718.	0.19	0.19	0.19	0.0	0.0	0.0	0.0	1.00	1.00	1.00	0.0	0.0	0.0	0.0
51	AFP	AFB	14000.	0.0	0.0	0.0	0.10	0.10	0.0	0.0	0.0	0.0	0.0	1.00	1.00	0.0	0.0

FIGURE 11 -- EXAMPLE 3: COMMAND AND BASE (BOS) PARAMETERS

TABLE 4 -- REPORT WRITER GROUP AND ACCUMULATOR DEFINITIONS (DEFAULT)

GRP-CODE	GROUP NAME	RELATIONSHIPS USED TO DEFINE GROUPS				
1	STRATEGIC OFFENSIVE	PE-CODE	>	0	AND PE-CODE	< 12000
2	GENL PURPOSE-FORCES	MSN-CODE	=	2		
3	INTELLIGENCE & COMM	MSN-CODE	=	3		
4	AIRLIFT (IF)	MSN-CODE	=	4	AND SUB-CODE	> 0
5	A F R FORCES	MSN-CODE	=	5	AND CMD-CODE	< 55
6	RES & DEVELOPMENT	MSN-CODE	=	6		
7	CENTRAL SUPP & MAINT	MSN-CODE	=	7		
8	TRNG,MED & PERS SUPP	MSN-CODE	=	8		
9	ADMINISTRATION	MSN-CODE	=	9		
10	SUPP OF OTH NATIONS	MSN-CODE	=	10		
11	STRATEGIC DEFENSIVE	PE-CODE	>	11999	AND PE-CODE	< 20000
12	AIRLIFT (NON-IF)	MSN-CODE	=	4	AND SUB-CODE	= 0
13	A N G FORCES	MSN-CODE	=	5	AND CMD-CODE	> 54

ACC-NMBR	ACCUMULATOR NAME	SUM OF GROUPS
1	TOT STRATEGIC FORCES	1 11
2	TOTAL AIRLIFT FORCES	4 12
3	TOTL RESERVE & GUARD	5 13

TABLE 5 -- ALTERNATIVE (USER DEFINED) GROUP AND ACCUMULATOR DEFINITIONS

GRP-CODE	GROUP NAME	RELATIONSHIPS USED TO DEFINE GROUPS				
1	STRATEGIC OFFENSE	PE-CODE	=	65000		
		PE-CODE	=	64001		
		MSN-CODE	=	1	AND PE-CODE	< 11300
2	STRATEGIC DEFENSE	PE-CODE	>	11999	AND PE-CODE	< 12800
3	STRAT CMD/CON/COMM	PE-CODE	=	12810		
		MSN-CODE	=	1	AND PE-CODE	< 12801
4	TACTICAL AIR FORCES	PE-CODE	=	64000		
		PE-CODE	=	63000		
		PE-CODE	>	50400	AND PE-CODE	< 51500
		PE-CODE	>	50000	AND PE-CODE	< 50300
		PE-CODE	>	24120	AND PE-CODE	< 24140
		MSN-CODE	=	2	AND PE-CODE	< 24110
5	AIRLIFT FORCES	MSN-CODE	=	5	AND PE-CODE	< 51700
		PE-CODE	=	45500		
		MSN-CODE	=	4	AND PE-CODE	< 45100
6	RESEARCH & DEVELOP.	MSN-CODE	=	6		
7	BASE OPERATING SUPPT	SYS-CODE	=	4		
8	TRAINING	PE-CODE	=	81000		
		MSN-CODE	=	2	AND PE-CODE	< 24140
9	OTHER SUPPORT & LCE	ID-CODE	>	0		

ACC-NMBR	ACCUMULATOR NAME	SUM OF GROUPS
4	TOTAL STRATEGIC	1 2 3
5	TOTAL MISSION FORCES	1 2 3 4 5
6	TOTAL GENERAL SUPPT	7 8 9

At the lowest level, planning elements can be assigned to groups according to their identification codes (ID-CODE), codes that uniquely identify each planning element. This capability permits the analyst to examine the resource requirements of virtually any subset of the force,* and several different cross-cutting groups can be examined by using different sets of group definitions on the same FORCE output data in separate REPORT WRITER runs.

In addition to the above-mentioned flexibility in defining summary totals, the REPORT WRITER provides flexibility in output selection, which permits examination of user-defined subsets of resources. The default cost element and appropriation structure used in the REPORT WRITER is shown in Table 6. The analyst can selectively display specific cost elements or appropriations--a capability that would be useful, for example, in identifying which planning elements were the major consumers of, say, aircraft modification costs, without having to thumb through full cost reports for all planning elements. The analyst can also redefine appropriations and subtotals (using the code numbers listed in Table 6) in order to examine resource totals that cut across appropriation lines.

The REPORT WRITER capabilities mentioned above provide the analyst with a powerful means of focusing attention on the forces and resources of primary concern to a particular study or planning exercise. Additional facilities are available in both the FORCE program and the REPORT WRITER to reduce the volume of output--and thereby make the results easier to analyze and interpret--by printing report information only for a selected set of planning elements. Thus, when a number of force structure or policy variations is to be examined at the same time, the analyst can select output reports for only those planning elements he has changed (from previous cases or from the base case) and for the support elements that are affected as a consequence. In all cases the

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*A planning element cannot be subdivided by this means or allocated in parts to different groups, and it cannot be added to more than one group total in a single REPORT WRITER run. Note, however, that a *Program Element* may be composed of several planning elements and thus can be divided among different groups.

TABLE 6 -- REPORT WRITER APPROPRIATIONS, COST ELEMENTS, AND SUBTOTALS
(DEFAULT STRUCTURE)

LINE TYPE	CODE	NAME
APPN	1	AIRCRAFT PROCUREMENT
CE	11	AIR VEHICLE
CE	12	INITIAL SUPPORT
CE	13	MODIFICATIONS
CE	14	COMMON AGE
CE	15	REPLEN SPARES
CE	16	WAR CONSUMABLES
CE	17	OTHER CHARGES
APPN	2	MISSILE PROCUREMENT
CE	21	AIR VEHICLE
CE	22	INITIAL SUPPORT
CE	23	MODIFICATIONS
CE	24	REPLEN SPARES
CE	25	OTHER CHARGES
APPN	3	OTHER PROCUREMENT
CE	81	ELEC&COMMUN EQPT
CE	82	INITIAL SUPPORT
CE	83	CRYPTO EQUIPMENT
CE	84	MUNITIONS
CE	85	VEH+BASE EQUIP
APPN	4	MIL CONSTRUCTION
CE	31	MIL CONSTRUCTION
APPN	5	R D T & E
CE	641	CIVILIANS
CE	642	MISC SUPPORT
CE	643	PURCHASED MTCE
CE	644	POL
CE	645	SYS&GEN SUPP MTL
CE	646	OTHER O&M
CE	61	OTHER RDT&E
APPN	6	OPERATIONS AND MTCE
CE	41	CIVILIANS
CE	42	MISC SUPPORT
CE	43	PURCHASED MTCE
CE	44	POL
CE	45	SYS&GEN SUPP MTL
CE	46	OTHER O&M
APPN	7	MILITARY PERSONNEL
CE	51	OFFICERS PAY
CE	52	AIRMEN PAY
CE	53	PCS CHARGES
CE	54	OTHER CHARGES
APPN	8	A F R PERSONNEL
CE	71	A F R PERSONNEL
APPN	9	A F R OPERATIONS
CE	141	CIVILIANS
CE	142	MISC SUPPORT
CE	143	PURCHASED MTCE
CE	144	POL
CE	145	SYS&GEN SUPP MTL
CE	146	OTHER O&M
CE	72	OTHER A F R OPR
APPN	10	A F R OTHER
CE	73	A F R OTHER
APPN	11	A N G PERSONNEL
CE	74	A N G PERSONNEL
APPN	12	A N G OPERATIONS
CE	241	CIVILIANS
CE	242	MISC SUPPORT
CE	243	PURCHASED MTCE
CE	244	POL
CE	245	SYS&GEN SUPP MTL
CE	246	OTHER O&M
CE	75	OTHER A N G OPR
APPN	13	A N G OTHER
CE	76	A N G OTHER
APPN	14	AIRLIFT (IF)
CE	441	CIVILIANS
CE	442	MISC SUPPORT
CE	443	PURCHASED MTCE
CE	444	POL
CE	445	SYS&GEN SUPP MTL
CE	446	OTHER O&M
NON-ADD	91	DEPOT MAINT
NON-ADD	92	P C S TRAVEL
NON-ADD	93	MEDICAL ADDITIVE
NON-ADD	94	MISC SUPP-BOS
SUB-TOT	1	INVESTMENT
APPN	1	AIRCRAFT PROCUREMENT
APPN	2	MISSILE PROCUREMENT
APPN	3	OTHER PROCUREMENT
APPN	4	MIL CONSTRUCTION
APPN	10	A F R OTHER
APPN	13	A N G OTHER
SUB-TOT	2	OPERATIONS
APPN	6	OPERATIONS AND MTCE
APPN	7	MILITARY PERSONNEL
APPN	8	A F R PERSONNEL
APPN	9	A F R OPERATIONS
APPN	11	A N G PERSONNEL
APPN	12	A N G OPERATIONS
APPN	14	AIRLIFT (IF)
SUB-TOT	3	DEVELOPMENT
APPN	5	R D T & E

entire set of (total force) inputs is processed by the model, and the summary totals include the costs of all planning elements, including those for which individual planning element reports were not printed. The change in total force cost, rather than the details, may be the principal concern of the analyst, and in such cases he may wish to suppress all planning element reports and see only the summary totals.

V. APPLICATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

APPLICATIONS

The FORCE model was first used in the Air Staff in costing the Air Force Extended Planning Annex (EPA) in the fall of 1975. The current version of the model--the one described in this report--was delivered to the Air Staff in July 1976, and this version of the model was used in the costing and analyses for preparation of the Air Force EPA for fall 1976. The EPA is a 10-year extension of the five-year USAF Program Objective Memorandum (POM),* which is fiscally constrained by guidelines from the Secretary of Defense. This kind of long-range planning, in which plans that are a direct extension of the current program are evaluated within expected future fiscal constraints, is the sort of exercise for which the FORCE model is ideally suited. The FORCE model brings to this process for the first time the possibility of examining more alternatives and options in structuring the EPA forces (or similar exercises) than have been possible in the past.

Most of the planning activity in the Air Force involves separate segments of the force or separate functional areas rather than the total force, but many of these segments might also benefit from use of a total force cost model in evaluating future alternatives. Since the FORCE model operates on the principle of variations from a base case, the usual mode of operation is to hold most of the force and policy inputs constant while varying the inputs within a particular area. Thus, for example, in evaluating alternative forces of tactical fighters, an office could examine the alternatives while letting the rest of the force remain as specified in the base case. The advantages of using a total force model in analyzing subsets of the force are that the analyses can be kept reasonably consistent even across dissimilar subsets of the force and that they can be kept within resource constraints; or

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*Force structure profiles for the POM actually extend three years beyond the five-year cost profile. The EPA extends the cost profile to a full 15 years with a force structure profile that extends over the same period.

future resource conflicts can be anticipated and steps taken to resolve the conflicts.

Because of the FORCE model's special features in the areas of support activities, it lends itself to use in planning and analysis of support policy and support structure alternatives, as well as force structure alternatives. For the most part, the Air Force or Air Staff components concerned with BOS, training, central supply and maintenance, and other support activities have not previously been able to look at future options in terms comparable to force structure analysis. In the FORCE model it is possible to do this. For example, a revised basing structure might be simulated by revising either or both of the sets of factors for fixed (per base) and variable (per man supported) BOS requirements for any of the command and base-type categories used in the base case. The model would then show the total force cost effect of the changes, including the impact, if any, of future force changes included in the base case, and including the effect of BOS changes on requirements for training, medical, and other support categories.

As mentioned in Sec. II, the FORCE model is intended to provide a framework for resource analysis research, in addition to its application to analysis of force and policy alternatives. The model was used at Rand in this function in the development of techniques for evaluating varying active/reserve force mixes in terms of total costs and capabilities.* This study required the development of methodology to evaluate reserve personnel costs and reserve unit operating costs (primarily for aircraft systems) in terms that were comparable in the total force to the cost and manpower requirements estimated for active force units. The methodology developed during this study and incorporated in the current version of the FORCE model includes: (1) special provisions for variations in reserve pay costs due to variations in average annual duty days for different categories of reserve personnel; (2) separate BOS factors to compute support for reserve units, including BOS provided by reserve personnel for units on active Air Force bases; and (3) special

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*A. Barbour, *The Air Reserve Forces in the Total Force, Vol. 2, Cost Analysis*, The Rand Corporation, R-1977/2-AF, forthcoming. Both AFR and ANG units are included in the general term "reserve units."

training computations for reserve personnel, to account for the fact that some reservists receive training during active duty service.

The concept of a weapon system's life cycle cost (LCC) has received a good deal of attention in recent years. This subject is another for which the FORCE model could serve as a suitable research framework--particularly in the area of operating and support costs. The LCC of a weapon system can be thought of as the increment in total force cost when the system is added to the force, the rest of the force being left unchanged. The total force framework helps to identify the elements of cost that should be included in a model of LCC and to focus attention on major planning and policy variables (e.g., aircrew ratios, use of simulators, basing mode, maintenance policy) as distinguished from parameters of the weapon system (e.g., weight, speed, reliability/maintainability). It also serves to establish consistent rules or factors for including the cost of BOS, training, and other centrally provided support services in LCC estimates for different types of systems. An LCC model must, of course, be more detailed, and must be sensitive to a greater number of variables than the aggregate weapon system subroutines used in the FORCE model; but the total force cost framework determines how the results of LCC studies for new systems relate to current resource requirements and thus, finally, to the question of what changes in forces, policies, or available resources must be made in order to bring the new systems into the force.

SUGGESTIONS FOR MODEL IMPROVEMENTS AND FURTHER RESEARCH

The model brings a number of advantages to the tasks of studying and analyzing future Air Force policy and weapon system options. It also permits the analyst to build alternative total force options that are feasible both within the constraints imposed on future resources and within the constraints implied by existing programs. It extracts these advantages at a price, however: the careful formulation at periodic intervals of a base case, which (1) describes current programs and forces and (2) establishes the activity rate, manpower, and cost relationships appropriate for future extensions of current forces and for the various policies and force structures to be analyzed in the next

planning exercises. Much of the information required for formulation of a base case is generated as an adjunct to the periodic updates of the F&FP and the *USAF Program* (P-series) documents and to updates of AFR 173-10 planning factors. Factors and parameters for new systems must be prepared (or maintained) as they are required in Air Staff studies and planning exercises. Although getting this information together for input to a FORCE model base case involves a considerable concentration of effort, the information collected is virtually all needed in standard, weapon system studies. In this sense, the preparation of the base case is a useful device by which a consistent and complete set of resource estimating relationships can be maintained. The mechanical tasks of coding, verifying, and testing the model inputs are not trivial, however, and some suggestions are presented below for dealing with these problems.

Experience has shown that cost models must be amenable to changes if they are not to be made obsolete in a short time. A considerable amount of flexibility, in the use of very general forms for cost and manpower relationships, gives the FORCE model the ability to adapt to changing concepts. But generality is a mixed blessing--if the form is too general, the analyst must essentially define his own model in each instance and simply use the computer program to perform the actual calculations. For this reason, the FORCE model has a number of built-in computational relationships to ease the input burden for standard situations. This is most apparent in the aircraft systems computations, which make use of standard cost factors (per unit equipment or per flying-hour) and aircrew and maintenance manpower calculations. The support subroutines also use some degree of built-in cost and manpower relationship forms. Because "standard" situations change over time, and because improved understanding of support structure is likely to change both the forms of estimating relationships and the suitability of the built-in aggregate measures of support demand or support policy, the FORCE model computer programs have been written to aid the programmer and cost analyst in redesigning individual segments of the model without requiring revision of the entire model.

A number of suggestions for enhancements to the FORCE model's capabilities were made even as the current version of the model was being completed; and, as is the nature of many large computerized models, other ideas for improvments will be stimulated by use of the model. In the following discussion, we divide these potential future changes into three areas: (1) enhancements to the input/output and job setup procedures to ease the mechanical burden of base case preparation and further improve turnaround time for processing alternatives; (2) provisions for including retirement pay costs, other below-the-line costs, and cost escalation estimates; and (3) improvements in the weapon system and support submodels.

Input/Output Enhancements

Much of the mechanical effort required in preparing base case inputs for the FORCE model is due to the fact that data must be taken from printed reports, then transformed (by simple additions or multiplications) or simply copied directly to coding sheets, key-punched, verified, and then run through the model and checked against the F&FP results that the data are intended to represent. The need to pass through several steps makes the possibility of error rather high, and finding and correcting the errors can be particularly troublesome. Two possibilities exist to improve this process. The first is to provide for direct transfer of those data already in computerized form. While this would be useful in eliminating some sources of error, the cost analyst must still have an input to virtually all of the data, if for no other reason than to specify which resources should be projected at a level-of-effort and which are discretionary (i.e., are one-time requirements). The second possibility is to provide for on-line, direct editing and processing of inputs.

At Rand, security for classified input data required that only a batch processing mode be used for the FORCE computer programs. If provisions can be made for on-line processing within the Air Staff, it becomes practical to prepare or edit inputs directly and to make FORCE model runs of only one or a few planning elements at a time, so that inputs can be verified (through the model) at once. This would reduce

the number of steps by eliminating the coding and key-punch/verify steps, and would avoid the necessity of scanning a full set of inputs after each change.

Retirement and Indirect Support Costs

Military retirement pay (for retired Air Force officers) is often included as an Air Force cost in studies. The FORCE model currently has no provisions for including this cost, nor does it provide for unfunded civilian retirement pay. For analytical purposes, the most important retirement costs to include are the implied future obligations for current personnel. It is unlikely that pay for current retirees would be affected by the kind of policy or force structure options for which the FORCE model is suitable.*

For some purposes it is useful to see the imputed variable support cost as a below-the-line cost for mission planning elements. The FORCE model currently shows these for PCS, medical, depot maintenance, and a portion of BOS cost. The model structure precludes the definition of simple cost factors for variable training and the rest of BOS cost, because of the interaction among other force elements that affects these support elements. But it could be useful if provisions were added to permit simple factors to be used to *approximate* the below-the-line variable support cost for each mission planning element.

Cost Escalation

To assure a consistent analytical basis over time, the FORCE model deals only in constant dollars. Nonetheless, the effects of possible future inflation on dollar requirements may be of interest in some kinds of analysis. The REPORT WRITER program could be modified (a tedious, but conceptually simple task) to permit the application of inflation or cost escalation factors at the appropriation or cost element level. This would permit the analyst to examine results for a single force structure of alternative assumptions about future inflation rates in a consistent fashion.

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*The FORCE model may not be a good tool for examining retirement pay policies that might affect current retirees. Retirement pay would be included as an added cost of the manpower required, to take fuller account of the dollar cost of personnel.

Weapon System and Support Submodels

The overall structure of the relationships between and among force and support elements in the FORCE model is a new concept in force costing. Because our understanding of the factors that drive resource requirements is far from complete, our submodels for support planning elements are largely based on prior models, which may not have taken sufficient account of the interactions among the many elements of the total force. Additional research is needed to improve the submodels and to increase the portion of the total force that can be modeled instead of simply taken as a throughput. There are any number of candidates for research. Those cited below are important because of the substantial levels of resources they require.

MFP 7, Central Supply and Maintenance, includes several program elements that account for central supply, procurement, and management activities and second-destination transportation costs. Like depot maintenance, these services are provided to various users throughout the Air Force, but no procedures have been developed to estimate how requirements for these support services are generated by the rest of the force. By default, the resources allocated to these central supply services have been treated as fixed, level-of-effort requirements; but the total cost of these elements equals or exceeds depot maintenance costs (for active USAF elements). A research effort is needed to determine the central policy variables and force-generated demand measures that drive resource requirements for these services. This would provide a basis for better projections of the future impact of force structure and support policies on this segment of the Air Force.

The only weapon system cost models generally used in the Air Force are those for aircraft and missile systems, but many of the elements of the force do not fit into these categories. We have discussed separate submodels for certain support activities, but a significant portion of Air Force resources is devoted to surveillance, and command, control and communications (CCC) elements, which appear to be more a part of the mission force structure than of the support structure. Research is needed in these areas also--particularly in the areas of land-based and space surveillance and sensor systems--so that better measures of

their resource requirements can be developed. This problem is not restricted to total force costing alone. Cost analyses of individual surveillance and CCC systems are currently required from time to time. Because it deals with the total force, however, the FORCE model emphasizes the number of such systems currently in the force, the sizeable cost and manpower requirements they generate, and the absence of any established methods for estimating their requirements under changing future conditions.

VI. CONCLUSION

The FORCE model is now a fully operational tool for examining resource requirements for future Air Force support structures and policies, and future force structure alternatives. It provides a means of representing all mission and support elements of the Air Force in a common framework and of estimating their dollar and manpower requirements for a 15-year future time horizon in terms comparable to the *USAF Force and Financial Program*. It gives special attention to several categories of support activities--treating both the support demands generated by other Air Force activities and support policies or structures that are substantially or entirely independent of overall force levels. When a base case is constructed, the model permits easy manipulation of individual weapon and support elements of the force with internalized routines to deal with standard relationships, which helps to assure relatively quick turnaround in using the model. Provisions for multiple, varied output formats and output summaries facilitate use of the model in studies and analyses of different parts of the force or of different functional and resource categories within the Air Force. Since its coverage of cost and activity in the Air Force is comprehensive and since it provides the means of assuring consistent estimating relationships, the FORCE model also serves as a suitable framework for research in Air Force cost analysis.

Further developments in computer support for the model may provide for extremely short turnaround times--thus permitting an even wider selection of future alternatives to be examined in the planning process. Further development in estimating techniques, using the model as the framework for research, can expand our ability to address complex force structure and support policy problems in studies and planning exercises. In its present form, and with the appropriate application of current estimating techniques, the FORCE model provides a comprehensive and consistent means of evaluating force and support alternatives. It also provides a unique ability to match resource estimates for future total force options to the constraints and implications of current Air Force programs.

Appendix

GENERAL DESCRIPTION OF PLANNING ELEMENT COMPUTATIONS IN THE FORCE MODEL

The costs and manpower requirements in the FORCE model are calculated planning element by planning element. Each one is assigned to a subroutine for calculations, according to the "system type" assigned to the planning element. Table A.1 lists the system types and codes used

Table A.1

PLANNING ELEMENT SYSTEM TYPES

Code	System Type	
0	Standard Systems	Mission Systems
1	Aircraft Systems	
2	Missile Systems	
4	Base Operating Support	Support Systems
5	PCS Travel	
6	Training	
7	Depot Maintenance	
8	Medical and Other Personnel Support	

in the model. System types are grouped into mission system and support system categories. The primary distinction between the mission and support categories is that the former are independent elements of the force (in terms of the relationships built into the model), whereas the latter are partly dependent in their resource requirements on various forcewide measures of demand for support services.

The general input structure for each planning element includes the following data elements:

(1) Planning element identifiers--title, identification code, command, etc.
(2) Force structure
(3) Manpower factors
(4) Activity levels (e.g., flying hours)

(5) Procurement/delivery schedule and cost functions and factors
(6) Fixed (over time) cost factors
(7) Throughput and variable (over time) cost factors

The analyst provides input data for any or all of these data elements as required for each planning element, and the model computes resource requirements for the planning element in terms of costs by cost element, and of manpower by personnel type.* Some cost-per-man-year factors, such as pay and allowances costs, are defined at a forcewide level in the model; but most cost factors and functions are defined at the planning element level.

The general form of the calculations for each planning element provides for manpower to be computed as a function of force levels, activity rates, and/or support demand (for support systems), and activity levels to be computed as a function of force levels and/or aircrew ratios (for aircraft systems). Annual operating costs are computed as functions of force levels, manpower requirements, and activity levels. Development and procurement costs may be throughput (when calculated outside the model), or the user may supply inputs for the model to perform the calculations and time-phase the costs in accordance with the force phase-in for the planning element. Other costs (e.g., military construction, other procurement) may be throughput for any cost element. Variations in calculations for each of the system type subroutines are given below.

Standard Systems (Type 0)

This is a generalized type of system that can be used for any planning element that does not match the more specific weapon system and

*Cost elements, which sum to appropriations, are listed in Table 6, Sec. IV. Personnel types are user-defined as part of the general, forcewide inputs to the model. A typical set of personnel types would include: pilots, other rated officers, non-rated officers, rated airmen, other airmen, civilians, etc. The analyst can define as many as 24 personnel types using whatever breakdown is suitable for his purposes. The model summarizes manpower requirements by officers, airmen, civilians and AFR/ANG officer, airman, and technician categories.

support system types. The force structure is described in terms of "planning element units," which may be defined by the user as squadrons, sites, bases, or other appropriate units.* Costs can be throughput without regard to force structure, but manpower requirements cannot; so the user should, as a minimum, specify a force level of 1 "unit" or "total" for planning elements that have no convenient other force level units. Activity rates are described in terms of user-defined "activity units." These may be defined as flying hours, alert days, etc., or simply be left out if force structure and manpower are sufficient by themselves to generate the annual costs for the planning element.

Force Structure. Input as end-year number of PE units for each year (years 0 through 17).

Manpower. Input, by personnel type, as end-year men per PE unit for each year.

Activity Levels. Input as average annual activity units per PE unit for years 1-15.

Procurement. A "delivery schedule" may be input directly (in terms of units delivered in each year) or generated automatically as a function of the planning element force structure (in terms of units delivered per PE unit phased into the force). This is translated into a "buy program" (units for which funding is required in each year) using a lead-time specified in months. A log-linear, cumulative-average cost-quantity function† is specified by a first-unit-cost and slope, and is used to compute the TOA required in each year. A fraction of the computed TOA for each year may be shifted one year earlier in time, representing "advance buy" for long lead-time components. An additional fraction of computed cost or cost-per-unit may be added for initial support (e.g., initial spares). Development costs are input terms of total TOA and are time-phased in relation to the first year in which

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*Planning element units will be referred to as PE units.

†The form is: $C_q = Aq^b$, where C_q is the cumulative-average cost-per-unit at the qth unit, A is the first unit cost, and b is the exponent. If s is the input value for the slope (in fractional form), then b = (log s)/(log 2). The model also permits a segmented log-linear relationship, with two "break points" where the slope may change.

units are delivered (the "IOC" year) according to a user-defined or model-selected RDT&E time-phasing profile.

Fixed Cost Factors. Input as cost-per-PE-unit or cost-per-activity-unit. The input structure provides a selected set of common cost elements for fixed cost factors (primarily for aircraft system planning elements).

Throughputs and Variable Cost Factors. Inputs may be specified for any or all cost elements and may be throughput for each of years 1-15, or may be defined as average annual cost per PE unit, cost per activity unit, cost per manyear for several different categories of manpower (e.g., officers, airmen, civilians), or any combination of the above. Costs generated in this way are added to (not substituted for) any costs that may have been generated in the same cost elements by the fixed cost factors or the forcewide factors.

Aircraft Systems (Type 1)

Force Structure. Input as end-year number of *squadrons* and UE-aircraft-per-squadron.

Manpower. Input, by personnel type in any of four forms: (1) end-year men-per-UE, (2) end-year men-per-squadron, (3) aircrew calculation, or (4) aircraft maintenance calculation. The aircrew calculation uses a yearly variable aircrew ratio (crews-per-UE) and fixed crew composition (men, by personnel type, per crew). For the aircraft maintenance calculation the model computes peacetime requirements (number of manpower positions) for each year using total planning element flying hours, input maintenance-manhours-per-flying-hour (MMH/FH) factor for the planning element, forcewide, standard peacetime maintenance productivity (direct man-hours per man per month), and a fractional, add-on maintenance adjustment factor (for Chief of Maintenance and other functions not included in MMH/FH estimates); wartime requirements are computed, where needed, using a wartime flying-hour rate (per UE) and wartime maintenance productivity. The model uses the greater of the two computed figures as the total manpower requirement. Inputs by personnel type specify the distribution of the total (e.g., 2 percent officers, 80 percent airmen, 18 percent civilians). Any combination of the

four forms of manpower calculations may be used for any personnel type. Thus, total manpower requirements for an aircraft system planning element may vary with the number of squadrons, UE per squadron, aircrew ratio, and peacetime or wartime flying hours.

Activity Levels. Activity units are defined by the model to be flying hours, and they may be input as average annual flying hours per UE or flying hours per aircrew. Fixed overhead equivalent aircrews and flying hours per overhead aircrew may be added if required.

Procurement. Inputs and calculations are similar to those for system type 0 except that the computed-deliveries variable is in terms of delivered *units-per-UE-aircraft* rather than units per squadron.

Fixed Cost Factors. Similar to system type 0 except that the inputs are in terms of cost per UE, cost per aircrew, and cost per flying hour. The cost elements chosen generally match those used in the AFR 173-10 CACE model. The model also permits sets of standard cost factors (and MMH/FH factors) to be defined, by aircraft equipment name (e.g., B-52G, F-4E, EC-135), as part of the forcewide inputs. When this is done, the user need not supply these inputs at the planning element level unless he wishes to override one or more of the standard values for a particular element.

Throughputs and Variable Cost Factors. Same as for system type 0, except that force-level factors are in terms of cost per UE rather than cost per squadron.

Missile Systems (Type 2)

Force Sturcture. Similar to aircraft systems: input as end-year number of *squadrons* and UE-missiles per squadron.

Manpower. Input, by personnel type, as end-year men per UE and/or men per squadron.

Activity Levels. Input as average annual activity units (user-defined) per UE.

Procurement. Similar to aircraft systems: computed deliveries variable is in terms of delivered units per UE missile.

Fixed Cost Factors. Similar to aircraft systems; inputs in terms of cost per UE and cost per activity unit.

Throughput and Variable Cost Factors. Same as aircraft systems: force-level factors are in terms of cost per UE.

Base Operating Support (Type 4)

The basic format and calculations for BOS planning elements are virtually the same as for system type 0 except for the addition of BOS support demand variables. A number of categories of bases (command/base types) are defined as part of the forcewide input data for the model. Each planning element in the FORCE model input stream is assigned to one of these base types, or the forces for a single planning element may be divided (beddown) among several base types. The manpower associated with the planning elements is then accumulated, in proportion to the beddown of forces, against the various base types. A BOS planning element may be used for each of the base types to generate BOS requirements, and the manpower accumulated against the base type designated for a particular BOS element serves as the measure of demand for BOS services.

Force Structure. Same as system type 0. Typically, the PE units would be bases.

Manpower. Input, by personnel type, as end-year men per PE unit (i.e., per base), and men per variable BOS position. The total number of variable BOS positions in each year is computed using the total manpower supported (for the base type) in each year in conjunction with variable-BOS-manpower factors (variable BOS positions per man supported--usually a fraction), which are part of the base-type input values. Thus, manpower for BOS planning elements varies both with the number of bases and the number of personnel supported on those bases.

Activity Levels. Input as average annual activity units (user-defined) *per man supported*. The activity units may be equated to total personnel supported simply by entering "1" as the activity level. The total personnel-supported figure for the base type may be weighted by personnel category (e.g., military could be given a weight of 1 and civilians a weight of 0.5, if civilians were considered less important in determining variable BOS costs).

Procurement. Usually not used for BOS systems. If it is used, the format and calculations are the same as those for system type 0.

Fixed Cost Factors. Same as system type 0. The factors can be interpreted as cost per base and cost per man supported.

Throughput and Variable Cost Factors. Same as system type 0.

PCS Travel (Type 5)

This system type is identical to system type 0 except for one element of cost--the PCS Travel cost element. PCS costs are calculated as below-the-line (non-TOA) costs for individual planning elements. The system type 5 planning element takes the accumulated total PCS travel costs (from planning elements that precede it in the input stream) and generates an equivalent above-the-line cost in cost element 53 (PCS travel). This accords with the practice adopted in the F&FP, where all PCS travel costs are accumulated in one Program Element. Normally this planning element should be the last one in the input data set, in order to assure that all (below-the-line) PCS costs have been generated before the PCS Travel planning element.

Training (Type 6)

Training planning elements may be used for six different training categories, designated by subsystem codes as follows: (0) officers training school (OTS), (1) recruit training, (2) technical training, (3) professional training, (4) undergraduate pilot training (UPT), (5) undergraduate navigator and other flight training (UNT). The personnel type definitions, included in forcewide inputs, specify a number of variables, such as turnover rates, average training course duration, and upgrade (advanced) training requirements, for each of the personnel types and training categories, as appropriate. These variables are combined with overall manpower requirements in each year to generate training loads, in terms of trainee manyears, in each year, for each of the six training categories. Training load calculations are discussed at the end of this appendix. A training planning element for a particular training category uses the training load as the measure of demand for its support services.

Force Structure. Same as system type 0. Typically, the PE units would be training bases or training centers.

Manpower. Input, by personnel type, as end-year men per PE unit and men per trainee manyear. The trainee load may be augmented, prior to other manpower calculations, by throughput, additional trainees (trainee manyears). The trainee load includes both PCS students, who are included in the training planning element manpower, and TDY students, who are assumed to be accounted for elsewhere. (Throughput trainees are always assumed to be TDY students.) Special provisions are made in the model for AFR and ANG training to account for prior-service AFR/ANG recruits and to generate PCS trainee costs in AFR and ANG planning elements (F&FP Major Force Program 5 Program Elements) rather than in the active Air Force training planning elements (MFP 8 Program Elements).

Activity Levels. Input as average annual activity units (user defined) per trainee manyear. For the flight training planning elements, activity units would usually be defined as flying hours, and overhead flying hours per pilot-instructor may be added to the student flying hours requirement. For non-flying training planning elements, the activity units may be equated to total trainee manyears by entering "1" as the activity level.

Procurement. If used, the format and calculations are the same as those for system type 0.

Fixed Cost Factors. Same as system type 0.

Throughputs and Variable Cost Factors. Same as system type 0.

Depot Maintenance (Type 7)

Depot maintenance planning elements are used primarily to account for industrially funded depot maintenance costs (DMIF) in a manner similar to that adopted in the F&FP. They can be used, however, to vary depot maintenance manpower as a function of DMIF demand (if an appropriate relationship can be established). DMIF costs, primarily based on standard, aircraft DMIF cost-per-UE and cost-per-flying-hour factors, are treated as below-the-line (non-TOA) costs for individual planning elements and are accumulated in four separate categories as follows: (1) active duty Air Force, (2) Air Force Reserve, (3) Air National

Guard, (4) Airlift Industrial Fund. A depot maintenance planning element uses a "subsystem" identifier to indicate one of these four categories or the total of all of them as the support demand measure for the planning element.

Force Structure. Same as system type 0. The force level is usually simply 1 "unit," but Air Logistics Center (ALCs) might be an appropriate unit.

Manpower. Input, by personnel type, as end-year men per PE unit and men per DMIF megadollar ($ million). Thus, manpower for a depot maintenance planning element may be varied with depot (ALC) structure, with total DMIF demands, or with some combination of the two.

Activity Levels. Input as average annual activity units per DMIF-dollar. Activity units can be equated to total DMIF dollars (in the designated category) by entering "1" as the activity level; this is useful as a means of generating above-the-line costs, where appropriate, by using a cost-per-activity-unit factor.

Procurement. If used, same as system type 0.

Fixed Cost Factors. Same as system type 0.

Throughput and Variable Cost Factors. Same as system type 0.

Medical and Other Personnel Support (Type 8)

This system type uses accumulated military personnel, in a designated category, as the measure of support demand. The category used is indicated by the subsystem type for the planning element as follows: (1) active duty officers, (2) active duty airmen, (3) active duty officers and airmen, (4) AFR officers, (5) AFR airmen, (6) AFR officers and airmen, (7) ANG officers, (8) ANG airmen, (9) ANG officers and airmen.

Force Structure. Same as system type 0. If used for the "Care in Defense Facilities" Program Element, "hospitals" would be appropriate PE units.

Manpower. Input, by personnel type, as end-year men per PE unit, and men per man-supported in the category designated for the planning element.

Activity Levels. Similar to the other support planning elements. Input as average annual activity-units-per-man-supported.

Procurement. Same as system type 0.

Fixed Cost Factors. Same as system type 0.

Throughputs and Variable Cost Factors. Same as system type 0.

Training Load Calculations

All training load calculations take place at the point in the input data stream where the first training planning element (system type 6) appears. Calculations are similar for all personnel types, but separate inputs are, of course, used for each. The basic requirement for replacements is computed from a turnover rate that is applied to the accumulated total personnel* in each year. To these are added (or subtracted) the increments or decrements from year to year in total manpower levels. The resulting total is the net requirement for replacements in each year.

The replacement requirements are translated into initial trainee manyears in each training category that is appropriate to the personnel type, by means of average course lengths and washout rates. The average course lengths also serve to time-phase the training requirements appropriately. In the case of recruit/OTS and initial technical training, the user can specify the fraction of replacements requiring that type of training (some officers will go through ROTC or the AF Academy instead of OTS, and not all airmen are given initial technical training). For the other training categories it is assumed that all replacements (for the particular personnel type) must proceed through any category for which non-zero input values are defined (e.g., all "pilots" must go through the UPT course).

Advanced or upgrade training requirements are calculated using advanced training rates for technical, professional, and flight (for UPT/UNT instructors--not Combat Crew Training) training categories. The advanced training rates are defined in terms of average annual advanced trainee manyears as a percentage of total force manpower. These

*That is, the personnel accumulated from planning elements that precede the training planning elements in the input data stream. Training elements should therefore be as near the end of the input data stream as practical.

may be divided among PCS and TDY trainees. The total of the replacement and advanced trainee manyears is the "training load" that is used by the system type 6 planning elements in their calculations.